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ABSTRACT

This monograph contains two studies in which the notion of intelligence as one general basic ability is rejected and in its place is posited the existence of a specific type of mental ability described as "spatial intelligence." "Spatial Reasoning and Its Measurement" investigates the process of spatial reasoning in the adult through an analysis of the level of manipulation of abstract mental imagery by assessing a "doodle" activity. Study results indicate that spatial reasoning is highly related to figural structures that allow for the mental manipulation of abstract mental imagery as a reasoning faculty. "Stylistic Independence in Art: Doodling as an Indicator of Idiosyncratic Expressiveness" presents a conceptual framework that characterizes doodle activity in adults as a consistency of figural relationships resulting in an artistic style. Results of a study reveal that the practice of graphic activity produces an individual artistic perspective, expressed in consistent figural markings, that links the activity of doodling to artistic development. Appendixes include a measurement scale for the spatial manipulation of abstract mental imagery and a classification of doodles. (YLB)

SPATIAL REASONING AND ADULTS

by

Sharon D. La Pierre

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FOREWORD

Traditional concepts of intelligence never have been very satisfactory to educators of adults. The very idea of developing a quotient based on age or grade level and some generalized concept of what a person should be able to do at that stage seemed implausible when applied to adults. Moreover, the satirical treatment given "intellectual geniuses" who can not perform the practical tasks of daily living have had too much basis in reality for educators to feel comfortable with academic definitions of intelligence.

The result was a tongue-in-cheek acceptance of the old saw: Intelligence is what an intelligence test measures. As J. Roby Kidd (1973) wrote in How Adults Learn, "This was amusing enough if not taken seriously, but it led to circumscribed views as well as definitions: intelligence was seen almost as a single quality. The growing realization that there are many capacities or abilities: mechanical, social, verbal, abstract, spatial-perceptual has also led to an appreciation that there are intelligences, not just intelligence" (p. 74). This idea of many capabilities was supported by practice in the field. The academically proficient adult was often outperformed on the job by his "less intelligent" counterpart. The creative individual provided insights to problems that the scholastically proficient struggled with in vain. For many adult education practitioners the pragmatic solution was a general disregard of the concept of intelligence.

In the studies described in this monograph, Sharon La Pierre has rejected the notion of intelligence as one general basic ability and posited the existence of a specific type of mental ability which she describes as "spatial intelligence." Not only does she provide evidence for its existence, but she also offers an instrument for its measurement. What an exciting concept for adult educators! Individual adults learn in distinctly different patterns not only because of different experiential backgrounds but also because of differing "intelligences." The implications for teaching, for curriculum and materials development, for critical thinking, and learning-how-to-learn programs are electrifying.

The Kellogg Center for Adult Learning Research at Montana State University was proud to support Sharon La Pierre as a postdoctoral fellow. Learning is central not only to education but to all of human life; yet it is a concept we know relatively little about. Cracking open doors that may give us new insight into how adults learn is a challenge worthy of anyone. We believe Sharon has responded admirably to that challenge and are delighted to share her work with you.

Robert A. Fellenz
Editor
May 1988

Spatial Reasoning and Its Measurement

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The purpose of this study was to investigate the process of spatial reasoning in the adult through an analysis of the level of manipulation of abstract mental imagery by assessing a "doodle" activity. The doodle activity was based on a conceptual framework regarding an individual, either child or adult, as reproducing markings naturally as a result of mental imagery that is usual to his/her own understanding or keenness of mental perception in terms of spatial organization. This organization of space is regarded as an intelligent act used to think and to solve problems without the use of the discursive mode, but rather, based on figural structure.

Two different sample groups were tested using the doodle activity or free drawing task. One group consisted of 55 subjects from advanced four year college fine art classes, and the other group consisted of 54 subjects from advanced four year college English classes. Two raters scored the doodle drawings using a measurement scale that was developed as a result of a conceptual framework based on design elements. The measurement scale was redesigned as a result of a pilot study that was run previously by the investigator. Statistical comparisons were made between the scores of the raters on the measurement scale and between the scores of the subjects from each group. This project examined the applicability of the measurement scale in determining an individual's level of spatial ability.

The results of this study indicated that spatial reasoning was highly related to figural structures that allowed for the mental manipulation of abstract mental imagery as a reasoning faculty. The results of this study also indicated that significant interrater reliability existed on the measurement scale and that the groups tested were significantly different, resulting in the art subjects scoring higher due to mastery level.

In 1987 a pilot study was run by the investigator (La Pierre, 1987) to build a conceptual framework for the purpose of supporting a linkage between spatial reasoning, as expressed in the organization of space delineated by abstract mental imagery, and artistic expression using design elements from the visual arts to analyze a "doodle" activity. An instrument was developed to analyze graphic behavior, doodling, or free drawing. The conceptual framework underlying that study took into consideration research available in the areas of graphic development and spatial cognition. The findings of such research were combined with knowledge about design elements (as found in the visual arts) to create a measurement scale based on figural structure. The measurement instrument used raters to score a doodle activity. The significance of linking artistic expression with spatial cognition in order to measure the process of the

mental organization of space and to indicate or predict the behavior of spatial thinking on a concrete figural level, was a pioneering endeavor.

Further research was needed in order to develop a more reliable measurement scale assessment procedure. A relationship between graphic activity, as expressed in doodle form, and design elements, as found in the visual arts, was indicated by the results of the original study. However, the limitations of that study did not permit strong generalizations to be made. The study did provide a strong foundation for further investigation in the area of spatial thinking in regard to the presented conceptual framework. This pilot study was the basis for further research intended to improve the utility and application of the measurement scale for the purpose of enhancing the understanding of the issue of spatial intelligence.

A Conceptual Framework

It is recognized in theory that spatial intelligence does exist and that many individuals utilize this manner of processing information as an effective way to solve problems (Gardner, 1985). Questions arise as to what is the advantage of being able to think spatially? Is spatial manipulation of concepts of equal importance to the logic of verbal or mathematical skills or does spatial knowledge, in combination with these two other mental competencies, form a unified mental framework necessary for general thinking activity? To what degree is an individual a spatial learner? The main issues that need to be explored are how spatial ability can be determined and what the components are that make up this form of thinking? To understand these kinds of issues, it was necessary to formulate a conceptual framework that explained the phenomena of spatial intelligence (as a rational mental act) and its properties as related to the individual.

Without the understanding of how spatial thinking affects individuals, education would be less "likely to guide them toward experiences that will take full advantage of their capabilities" (Dixon, 1983, p.50). The result of not fostering or understanding spatial processing as an individual learning and thinking method can produce imitative mental patterns that do not allow the individual to reach full cognitive expressiveness (e.g., Silverman, 1984).

Spatial thinking is an intelligent act that is not given equal consideration because it cannot be measured accurately at present and because it has not been defined as a rational reasoning process. However, the engineering field (product development and tool designing), some areas of the sciences (physics, for example), and designing in the visual arts utilize this form of thinking and recognize its practical applicability. If research and knowledge about spatial capabilities can be focused into a practical theory, spatial skill can be utilized as an effective way of manipulating and organizing space to express intelligence. This intelligence can be observed because of designated principles or criteria that allow an observer to see ability on a concrete level instead of making assumptions about the mental process.

The following sections are the foundational elements of the conceptual framework on spatial reasoning that were used to design this study: (1) the theory of spatial thinking; (2) the framework of the theoretical elements as

found in (a) the spatial thinking process, (b) the system of figural structure, and (c) the elements of organizational principles; (3) the spatial thinking process as related to individual artistic expressiveness; and (4) the summary of the overall conceptual framework.

Theory of Spatial Thinking

The theoretical basis for exploring the issues of spatial reasoning ability is rooted in the concept that it is equally as significant a competency as verbal and mathematical abilities. Spatial thinking, defined in this paper as the manipulation and organization of space to form abstract mental imagery, is governed by rules and syntactical operations that lead the thinker to perform unique problem solving solutions. The rules for spatial organization are based on design principles (the syntax of spatial language) that are expressed by the visual arts and that have been used and taught for decades. The use and development of these principles are part of a developmental thinking process that takes place in all normal human beings. The theoretical assumption is that like other mental competencies, certain individuals possess a visual expressiveness that is "native" to their thinking pattern. This basic talent or native ability develops into a practical intelligence that is characterized by flexible and fluid mental imagery--spatial thinking.

Piaget's stages of the development of spatial relations characterizes the human mental growth that takes place. He traced the infant's ability to move around in space to the toddler's ability to form static mental pictures or images. He further delineated the process of development to include the school age child who mentally develops the capacity to manipulate static images to the adolescent individual who relates spatial relations to propositional accounts (cited in Gardner, 1985, p.180). Futhermore, Kellogg (1969) characterized the child's growth by having cataloged hundreds of children's drawings and delineated a progressive development of "graphic activity" (a phrase used by Gardner, 1980). Kellogg's research into children's art lead her to state that "the visually logical system of child art represents 'visual thinking,' but this is not the same as rational thinking, language development, or the expression of emotional states "(Kellogg, 1969, p. 255).

There is a great disparity between a child's expressiveness and that of an adult. As a child, the development of spatial thinking is a process that all normal human beings encounter and unfold through maturation. Kellogg confirmed this by the categorizing of expressive movements and marks that normal children go through in drawing activity. It is a universal act of learning to see and to think by developing through action. Kellogg even went so far as to state that this development "is independent of associations or social environment" (Kellogg, 1969, p. 259). What she meant was that the process of drawing, thus developing spatial relations, was natural and universal to all children across cultures. Kellogg made this assumption based on her own analysis of child art.

In a review of the literature on children's drawings and how culture influences developmental growth, Ives and Gardner (1984) delineated a

progressive approach to this subject. Particular stages of development in children (at the first age level--ages 1 to 5) were genetically determined. That was to say, regardless of the environment, all children passed through similar developmental stages and in the same order. This early developmental knowledge became an unfolding process (in later age levels) as a result of interacting with the surrounding world. Ives and Gardner stated the following levels of development that allowed for this unfoldment. They were: (1) ages 1 to 5 where universal patterns emerged through sensory-motor exploration; (2) ages 5 to 7 where scene-like qualities and basic understanding of the elements as related to culture appeared (a transitional period from genetically dominated characteristics to a more individualized approach to cultural influences); (3) ages 7 to 12 where the height of culture influenced knowledge through learning, classifying, categorizing, and mastering (an extremely literal-minded state); and (4) adolescence where an ability to think on a more abstract, reasonable, and hypothetical plan was explored.

Through practice and maturity, adults can expand simple spatial organization into more complex ones (e.g., McKim, 1980). Those individuals who continue to grow and develop spatially are utilizing a preferred and, perhaps, "native" way of thinking. The act of thinking on a spatial level, like those of the verbal and mathematical modes, is an organized system of mental growth. As with other mental competencies, spatial ability develops into a more precocious talent for some individuals and can be observed through the natural inclination of a child or adult to "doodle" or draw these abstract mental images and their variations on paper. This visual representation of the thinking process is a means by which to determine and measure spatial acuity in an individual. A "doodle" represents the concrete expression of the individual's thought process.

Framework of the Theoretical Elements

In order to determine how to identify a spatially skilled individual, it was first important to identify the theoretical framework of elements that constitute and affect the qualities of spatial ability. The elements covered that constituted the conceptual framework of spatial ability were as follows: **(1)** the spatial thinking process; **(2)** the system of figural structure; **(3)** and the elements of organizational principles.

The Spatial Thinking Process

The act of thinking by conceptualizing spatially involves a distinction between what is observed with the eye (literal perception) and what is imaged in the mind. Spatial conception is the ability to image configurations in the mind not based on literal perception, but rather, the interpretation (expansion or "stretching") of that perception. Although the interaction of eye and mind cannot be separated, this subject is not the focus of this text.

Piaget made a distinction between "figurative" knowledge and "operative" knowledge as perceived by the mind (cited in Gardner, 1985).

Figurative knowledge was the ability to see a static configuration as a picture-image in the mind. On the other hand, operative knowledge was the ability to change or manipulate that mental picture-image by the transforming of its original conception. It is this operative ability that develops into organized abstract space in order to mentally reason within this realm. This ability to operationalize spatial manipulation is governed by a spatial "language" or system, and these formal rules manage the mental organization of space. This spatial language is rooted in figural structure, not in a discursive system, such as written or oral language. The elements of the system of spatial language or figural structure is explored in depth in a following section.

An example of mental manipulation, in its simplest form, is Piaget's concept of "decentration" (cited in Gardner, 1985, p. 179). This means that a child can rotate an object in space or determine the angle of perspective an object will take when a viewer is seated in another part of the room.

The spatial process begins with the mental imaging of a concrete object. Then this imaging develops into a manipulation of the static image and a transformation of the images into abstract spatial concepts in order to reason by spatial implications. Refer to Figure 1 as a visual example of concrete mental imaging and the spatial manipulation of that static image to form abstract imagery. Dixon (1983) described this spatial understanding as dependent "on grasping the consistency in relationships between things when these relationships occur in the context of fluid, changing patterns. The fluidity presents infinite possibilities like a face seen from different angles" (p. 27).

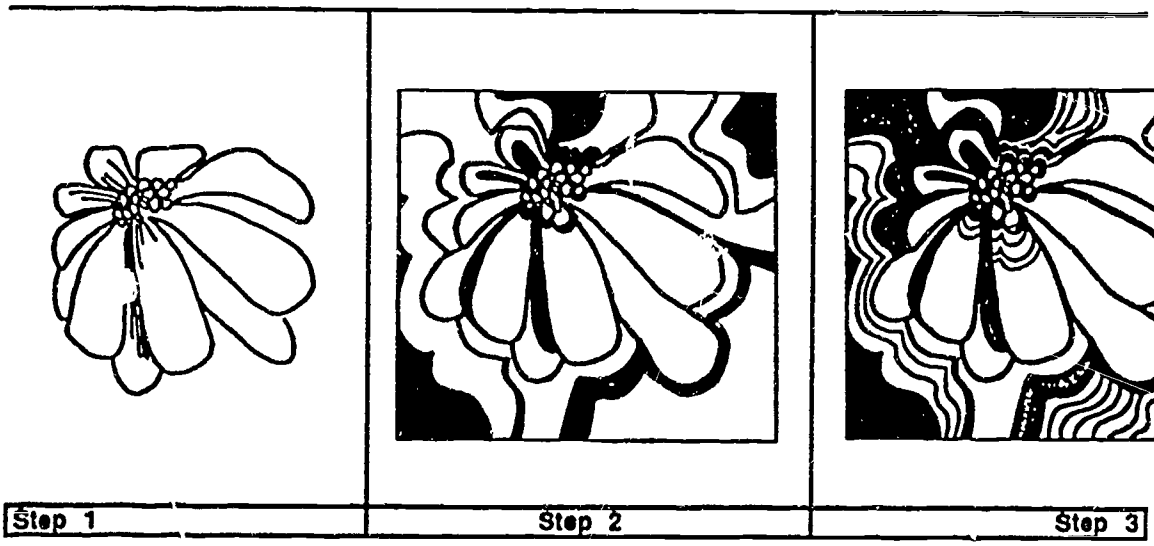

Figure 1

Step 1 is a visual example of concrete mental imagery in static form (a stylized flower). **Step 2** and **Step 3** are examples of the spatial manipulation of this static imagery to form abstract space. Each step represents varying degrees of manipulation.

The following topics were reviewed in the original pilot project (La Pierre, 1987). They included: spatial cognition; visual imagery and its function in memory to reason; and the visual arts and spatial understanding. It was concluded in the pilot study that the activity of spatial reasoning corresponded with the intellectual development of an individual. It was reported that it interconnected with language, perception, memory, imagery, and representative form (as seen in the visual arts). The components were interrelated to create a whole mental environment where the interacting of these parts (or raw materials) animated the total thinking process. The process of non-discursive structural thinking (spatial cognition) was an elemental factor embodied in the various characteristics of the mind. The content of this structure was dependent upon an unseeable format. Its makeup was not literal or linear in nature, but explicit in form. Therefore, imagery and memory provided schemata for the understanding of this spatial reasoning process. Refer to the "Reference" section of this paper for the listings of the works consulted for the original pilot study.

The difference between the visual artist and the mathematician, in terms of spatial manipulation, is the fact that logical reasoning can be followed in mathematics, as in language, by observing the linear progression and use of the governing rules. The apprehension by society of the visual artist as governed by intuition instead of reason, is the paradigm that perpetuates the belief that visual expression is a subjectively unmeasurable act. If, however, intuition is defined as "the subconscious accumulation of past experiences" (Koberg & Bagnall, 1976, p. 111), the problem becomes one of a thinking process that is not easily seen, but experienced through individual action. The fact is, there is more than one solution to a problem, and because there is no right or wrong answer, but rather various possibilities, this makes measurement subject to judgement and expert evaluation. These concepts set the stage for the next element in the development of this framework, that of the rules or system that govern spatial language by figural structure.

A System of Figural Structure

Eisner (1982) states that syntax need not be limited to discourse, because it means "an arrangement of parts within a whole" (p. 63). Spatial reasoning is governed by such a syntax. It is composed of a series of elements that are governed by unifying figural grammatical or organizational rules. These elements and their interlocking organization were observed first in nature, and through history they have been written down, expounded upon, delineated, and observed by artists, historians, critics, and aestheticians to be the basis of reasonable artistic representation. Pile (1979) verified this through the following example:

> We look at the sky and see, at first glance, a random arrangement of stars. But we resist that incomprehensible randomness and seek out, in defense, the stars that seem brighter, and soon patterns emerge that we can name and

> even identify with images of a dipper, a chair or a hunter wearing a sword in his belt. We have thus suddenly transformed randomness and chaos into memorable pattern that we carry about and refer to in the future. (p. 92)

Nature has a wealth of design elements in various configurations, and it is this storehouse that has been the observatory for the development of artistic ordering. For example, a flower is composed of large, medium, and small shapes in graduated forms. A flower is also composed of dark, medium, and light tonal variations and a richness of textures, both visual and tactile. The placement of these elements is transitional in quality--from small to large, from dark to light, from textured to no texture. Making these kinds of observations about space and its relationship of parts (composition) was what originally set the stage for design principles to be classified. Remender and Lucardi (1986) called the search for artistic excellence a construction created from shared social standards.

The main elements of design for this paper were extrapolated from Kepes (1964) and Wong (1972, 1977). Wong (1972) called these elements a "kind of visual logic" that create the possibilities for organization (p. 4). These same elements were found in other art books (Bevlin, 1980; La Pierre, 1983; Ocvirk, Bone, Stinson, & Wigg, 1981); variations in terminology were the only differences among authors. The elements and their utilization remained the same.

The following section on the elements and their organizational principles are the parts that comprise the system of spatial thinking. It is difficult to take these elements out of context because they are interrelated and their existence is dependent upon each other's utilization. Kepes (1964) stated the following about the laws of visual organization:

> Each representation of an object or a thing acts on the picture surface and discharges its own unique direction of associations as a point, a line, a shape, acts on the picture-plane, and forces the eye into virtual spatial directions. These representations have positions, direction, shape, size, distance, and weight. They can advance until one is keen to follow them, or they can recede so that one is willing to miss them. They have textures of sensory warmth; or they are cold, with geometrical or theorectical exactness. They have brightness and color and can move with various velocities. As one searches for spatial order, and through the interrelationships of the plastic forces creates a unified spatial whole, one also searches for a meaning-order and builds from the different association-directions the common, meaningful whole. (p. 202)

Elements of Organizational Principles

The manipulation and transformation of design elements give spatial language its abstractness. These elements become organizational tools, as opposed to rules, that allow conceptualization to expand into infinite possibilities.

Balance. This element is characterized by formal structure (symmetry) or informal structure (asymmetry). It allows for exaggerated and expanded concepts to be weighed against more subtle components and to appear as feasible solutions.

Color. When color is used, it changes the flow, movement, and direction of shapes because of its virtual sensitivity to formal relationships; futhermore, color can make shape either recede or appear smaller (as with dark tones) and advance or appear larger (as with light tones). Color (treated here in the context of this study includes black, white, and the greys--tonal aspects) is an element to be controlled by shapes, their gradated sizes, and their gradual tonal variations of dark, medium, and light. Bell (1981) considered color to be a "mode of form" having no significance as an end in itself. For the purposes of this experimental design, color was treated as black, white, and tonal greys.

Focal point, direction, flow, movement. An interrelationship of shapes creates a movement due to sizes, tones, and textures. A focal point is like the subject of a sentence, a concentrated structure. Lines or planes create shapes that direct and give purpose to this conceptualized structure by visually forcing the structure to flow out.

Form as volume. This includes perspective and depth. Volume can be created by shading, overlapping of shapes, linear perspective, or aerial perspective (change in tones from foreground to midground to background). Volume can be conceptualized as three-dimensional on a two-dimensional surface or as three-dimensional only.

Point, line, or plane. These become form or shape. They too possess variations in size, tone, and texture. These elements, when interlaced, can form structures and configurations that delineate space.

Positive and negative forms. "Form is generally seen as occupying space, but it can also be seen as blank space surrounded by occupied space" (Wong, 1972, p. 11). Balance is maintained by use of color (tones), size of shapes, and texture. The interrelationship of forms is dependent upon balance.

Shape. The element of shape is governed by the fact that it can be consistently repeated, as in a pattern (which is a form of texture), or it can be varied by size (small, medium, and large), or it can be shaded (dark, medium, and light). A transition of various contrasting size shapes and varied tonal contrasts are what give shape direction and purpose to create movement and flow.

Texture. Texture adds richness and a tactile quality to space and shapes. It is the surface characteristic of a concept or shape. Like color, the flexibility of texture is directed by gradated size of shapes (small, medium, and

large), the tonal quality (dark, medium, and light), and the relief quality of tactileness, all directing purposeful movement and flow.

Spatial Thinking as Related to Individual Artistic Expressiveness

The individual possesses characteristic thinking habits that are unique to his/her own artistic expressiveness. An examination of children's drawings, graphic development, scribbles, and doodles verified this statement (Arnheim, 1974; Gardner, 1980; Kellogg, 1969; Winner, 1982). Basic features of doodle or scribble markings are repeated and become characteristic of the individual artist. Kellogg (1969) confirmed this by emphasizing the significance of child art. She said:

> It seems to me that the inspired artist actually utilizes childhood's self-taught esthetic forms and releases energy for art similar to that released in childhood. He does this with controls learned through great discipline, acquired with age and practice. The artist's 'self-regulated regression' returns to scribblings but is not truly regressive if the purpose of the return is the utilization of scribblings' esthetic essence in an adult manner. The Scribbles [or non-representational forms] and the prepictorials of child art are the prima materia of all art. The use to which they are put is determined by the emotional and artistic maturity of the user. Every individual posesses the images of child art, but only the artist uses them consciously and with discipline, bringing them to life as the formal aspects of his work with paint, pen, or other materials. (p. 235)

Orban (1975) also confirmed the expressiveness of the individual when he stated:

> In the case of individual style, creative content--form, colour and space relationship--is the stronger element and the style is an unconscious outcome of the creative content. The individual style of a genius will sooner or later influence the general style. In the case of Cezanne this influence became apparent immediately after his death. In the case of El Greco it took centuries before his genius was really appreciated and his influence felt. (p. 39)

It is this ability of the artist, the development of spatial thinking and its expression of individual characteristics, that doodling captures (La Pierre, 1983). Doodles represent the individual's ability to think spatially and to express that ability in a concrete or objectified form.

Summary of the Conceptual Framework

The spatial thinking process is theorized by the investigator to be closely allied with the expressive elements that comprise the visual arts. The conceptual framework behind the development of spatial intelligence is rooted in the child's exploration of movement and the maturation encountered in drawing activity. This ideographic approach to the understanding of spatial development is considered to be of prime importance in the representation of spatial thinking. The graphic art of drawing (doodling or free drawing in this instance) is theorized by the investigator to allow the observer of this mental activity to bridge the gap between theoretical spatial knowledge and concrete utilization of its principles.

The Research Study

Background

This research project was based on the original materials piloted in the investigator's dissertation. The original material was reorganized to reflect knowledge obtained from the findings and from subsequent research. For example, in the original dissertation study a parallel measurement was used to test the validity of the measurement scale and to divide a sample group into spatial and verbal thinkers using four subtests from Guilford's "Structure of the Intellect" (SOI). However, it was determined that the constructs of the SOI and the measurement scale were theoretically different. It was also determined that reliability coefficients were low overall and that the scores on the measurement scale lacked variability. Further study of this issue determined that the measurement scale was a *criterion-referenced* test and, thus, distribution of scores tended to be more homogeneous because individual abilities were being measured and because a clustering of scores tended to take place. *Norm-referenced* test procedures cannot be used to evaluate *criterion-referenced* measurements (Hambleton, 1984; Hambleton et al., 1978). For example, a norm-referenced test is designed to maximize the variability of test scores; whereas, a criterion-referenced test is not. Therefore, the present research study was designed to test a "master" group and a "non-master" group to evaluate the measurement scale and to create more variability in test scores.

The measurement scale was expanded from 23 items to 29 items to take into account various kinds of line treatment found in doodles on the pilot study. For example, transparency was added as a perspective technique to create three-dimension through the overlapping of elements.

Before the study could proceed, it was also necessary to design a systematic training program for the rater of the measurement scale. A booklet, detailing clarifications on specific items and procedures for scoring, was produced and used in the rater training session.

Research Plan

Problem Statement

The logic of verbal and mathematical modes of thinking has attained such acknowledged educational status in the last several decades that the majority of students are forced to fit into these thinking patterns as the only ways to express reason, thus limiting alternative approaches to thinking style. Most educational testing is based on the achievement level of these two areas and many IQ tests are oriented toward verbal knowledge. College entrance examinations are broken down into verbal and mathematical skills, and spatial ability is not considered significant enough to be an independent testing category. Sternberg (1982) emphasized the point that testing validity varied across individuals and that many factors affected intelligence identification.

Historically, it has been recognized that a difference exists between the affective nature of sensory appeal and the dialectic (Waugh, 1986). Socrates supported the censorship and supervision of the activities of the visual arts. This was based on a belief that art was interwined with the moral obligation of teaching. Poetry, for example, was literature that affected the beliefs, attitudes, behavior, and practices of the audience. Therefore, art and reason must work together to uplift the individual morally. According to Waugh (1986) in a discussion of Plato's Republic, Socrates believed that knowledge of intelligible objects was only reached through the dialectic or rational logic. The basis for regarding the activities of the arts as inferior to the power of reasoning, was perhaps set by Greek philosophy. The union of the arts with reason was regarded only as a way to promote right thinking in the audience, because the arts had the capability of inspiring empathy and moving an audience's spirit through imagination. When the vehicle of education was no longer a poetic performance, the split between affective behavior and reason became greater with time and less concern was attributed to the artistic realm as a way of fostering knowledge.

Plato's regard for the senses as being untrustworthy because of the belief that its seductive nature kept mankind from knowing the truth was confirmed by Eisner (1982) . It is this historical view that has represented art as something separate from experience and knowledge. Therefore, the utility of artistic conceptualization is still to be explored.

It is recognized in theory that spatial intelligence does exist and that many individuals utilize this manner of processing information as an effective way to solve problems (Gardner, 1985). However, educational practices persist in upholding verbal and mathematical skills as the most important abilities to be developed by every student, regardless of individual thinking patterns. Therefore, assessment of an individual's mental abilities, strengths, and skills may not be accurate due to these present practices of excluding spatial development and measurement.

Purpose of the Study

The purpose of this study was to investigate in the adult the concept of spatial thinking through an analysis of the level of manipulation of abstract mental imagery, as measured by doodle activity. This study attempted to link spatial reasoning to design elements, as found in the visual arts, for the purpose of representing an internal process of the mental organization of space through the use of a free drawing doodle format for analysis.

Research Questions

The major research question was as follows: Can spatial thinking ability be measured through an analysis of an individual's doodle activity? Evidence for such measurement was indicated by investigating the following questions:

(1) Will a significant relationship exist between the cumulative total scores of the raters on the measurement scale?

(2) Will a significant difference exist between the mean cumulative total score of the raters on the measurement scale for the two groups?

(3) Will evidence of clustering be apparent for items on the measurement scale designed to measure similar traits?

Definition of Terms

Art. The term art was defined as a symbol system used by individuals within cultures for the purpose of communicating ideas, feelings, and emotions. This symbol system was considered to be based on the identifying of qualities, values, principles, judgements, and discriminations. Basic design elements were conceived of as one set of aesthetic judgements that govern artistic creations.

Cognition. The term cognition was used in the same manner Eisner (1982) used it-- to cognize is "to know."

Concrete imagery, visual imagery, visual thinking, pictorial thinking. These terms were used interchangeably to represent the ability to "see" an object or configuration in the mind, the memory of its features. These terms were defined as the ability to mentally reproduce (image, visualize, picture) a static symbolic form, or object, unlike abstract placement of space.

Concreteness. This term was used to represent a solid, tangible object or manifestation of an idea. An art object is an example of a concrete form.

Doodle. This is defined as a task that is characterized by free drawing activity that constitutes a conscious or unconsciously directed phenomena. The unconscious behavior can be solicited by activities such as daydreaming or talking on the phone. However, art students are taught to approach the act of creating as a conscious endeavor. This kind of training and practice can make the conscious level of graphic activity a directed and purposeful thinking process, reflecting the individual's unique patterns of thought.

Imaginal thinking. Imaginal thinking represents bits and pieces; the mental space is not all abstract, for only parts of it may be. It represents the

transitional stage between visualizing an object and breaking the object down into total abstract space, "fainting to the extent of being barely observable, ...indispensible to any mind that thinks generic thoughts and needs the generality of pure shapes to think them " (Arnheim, 1969, p. 115).

Manipulation of mental space, spatial relations, spatial thinking, spatial reasoning, spatial intelligence. The term manipulation was used by Dixon (1983) to mean a flexible, interactive, fluid, abstract operation. It is characterized by the converting of space (reorganization) to induce abstract or conceptual thinking.

These terms signify "an infinite system of interconnected perspectives in a person's mind such that the person can use this system to precisely and simultaneously understand the relationships between a host of things in the physical world" (cited in Dixon from Piaget's findings, 1983, p. 9). These terms are distinct from the static picture-like memory of objects.

Transformation. It was defined as an internal process that represented non-verbal space which functions in relationship to an externalized object and is characterized by the ability to recognize an object when its orientation has been changed or rotated.

Research Method

A measurement scale based on design elements was developed to measure the degree of spatial thinking in the individual. This scale was used to evaluate a "doodle" activity or free drawing that was administered to college students.

Two groups (totaling 109 adult subjects in all) were chosen from a population of volunteers. One group represented advanced four year college fine art students, and the other group represented advanced four year college English students. The purpose of the group separation was to test two distinctly different populations with the measurement scale and then to compare responses. The objective was to validate the doodle activity as an index of the quality of mental imagery based on the measurement scale criteria.

Each group completed the same doodle activity which was scored by two raters separately using the items prescribed on the measurement scale. A standardized doodle form and a number two soft pencil were given to each participant, and the doodle activity was administered and timed for 15 minutes. The participants were told to "play," "doodle," or "scribble" and to have fun being expressive, completing the doodle box in the upper half portion of the total form. The participants were instructed to concentrate only on abstract shapes and forms and to think in terms of their thought expressing space or visual thought as an inward experience to be objectified on paper.

It was theorized by the investigator that representational drawing is not related to general intelligence (general factor) and that this manner of drawing may represent a more talented or special gifts area (special abilities factor). Evidence supporting this belief can be found in the research of special artistic abilities done by Meier (Clark, Zimmerman, & Zurmuehlen, 1987). Depending on the kind of drawing skill being considered (such as representational, copying, symbolic, caricature, analytic, or impressionistic), drawing ability is

dependent upon intelligence in general and contributes to the success of an artist (from Hollingworth's theory as cited in Clark et al, 1987). Therefore, the investigator chose to use doodling or free drawing as a measure of spatial competence, so that a special ability in drawing would not be a factor in the measurement.

A descriptive form was attached to the bottom half of the doodle form to obtain name, age, gender, technical training, and art training (for those subjects in the English group). This portion was filled out prior to the timed doodle activity. A consent form was signed and dated by each participant before the testing began. This form had been reviewed and approved for use by the Committee on Research at the University of Denver. The subjects were instructed to write their native language on the descriptive form, if it was different from English.

The doodle form was then analyzed separately by two raters. One rater was the investigator; the other rater was a college fine arts teacher experienced in drawing, painting, and design. She had been a rater for the pilot study and was trained to use the measurement scale by the investigator.

The data was analyzed using descriptive statistics, correlational analysis, frequency distribution, analysis of variance, and qualitative analysis.

Subjects

The subjects totaled 109 students from Colorado State University, Ft. Collins, Colorado. The average age was 27.3 years, ranging from 18 to 58 years. There were 72 females and 37 males in the total group.

Fifty-five (55) subjects made up the art group, consisting of advanced fine arts students from painting and printmaking courses. Fifty-four (54) subjects made up the English group, consisting of advanced English students from literature, essay, and semantics courses. There were 37 females and 18 males in the art group and 35 females and 19 males in the English group. Five subjects declared another language as their native tongue, four from the English group and one from the art group. Seventeen (17) subjects had had some technical training, ten from the English group and seven from the art group. Fourteen (14) of the subjects from the English group had had art training, either in high school or college (one had a BFA). The average age of the art group was 26.2, ranging from 18 to 58 years, and the average age of the English group was 28.43, ranging from 19 to 50 tears.

Instruments

Measurement scale. An instrument that estimated to what degree an individual utilized the spatial manipulation of abstract imagery was redesigned from the investigator's previous research on spatial intelligence. It was used to evaluate a subject's abstract doodle. Design aspects of an individual's doodle activity strongly suggested spatial acuity, the ability to spatially manipulate abstract mental imagery (La Pierre, 1987). Each measurement scale item was developed from figural knowledge based on criteria from design principles. There were a total of 29 items.

The measurement scale was divided into categories corresponding to those design elements listed in the "Framework of the Theoretical Elements" section of this paper. The categories were as follows: pattern use; use of perspective and depth; balance; focal point or area of emphasis; and rhythm, flow, directional movement (see Appendix A for the measurement scale used in this study). The core of these elements dealt with the transitional variation of shapes from dark to light and from small to large. These transitions represented extended or expanded spatial thinking.

Each item was scored on a scale of one to five, using the following classifications: (1) no use; (2) limited use; (3) moderate use; (4) amplified use; and (5) consistent use. Figure 2 is an example of how each of these classifications was used in the measurement scale (see Figure 2). This particular example is item 17, the use of linear perspective with tonal gradation. The scoring was based on the degree to which the item was integrated into the doodle drawing.

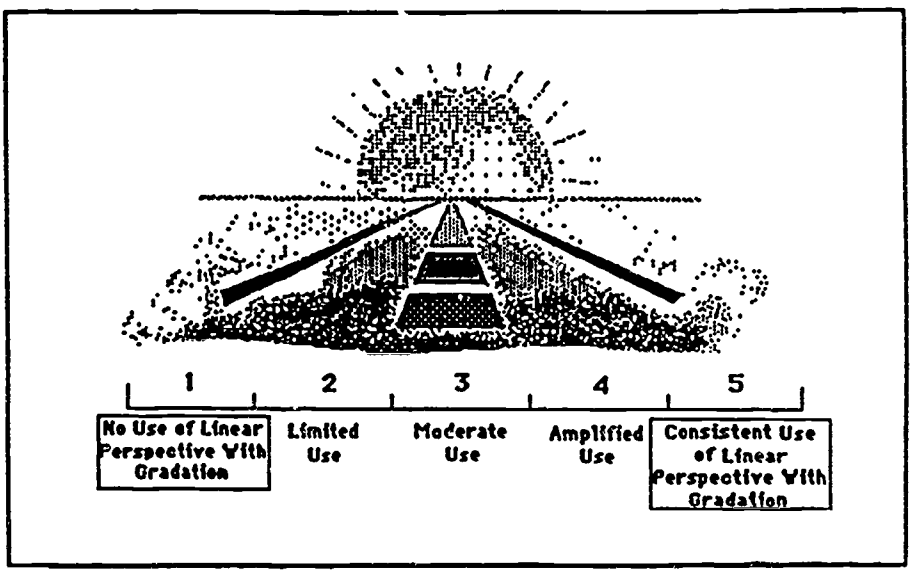

Figure 2

An example of the rating system for the categories of no use, limited use, moderate use, amplified use, and consistent use for item 17 of the measurement scale.

Doodle activity form. The doodle activity form (see Figure 3) was developed as part of the pilot dissertation project. Signal lines were used because it was originally determined that blank space was difficult for most individuals to handle, eventhough art students are trained not to fear a blank

piece of paper. For more details on the development of the doodle sheet refer to the pilot study (La Pierre, 1987).

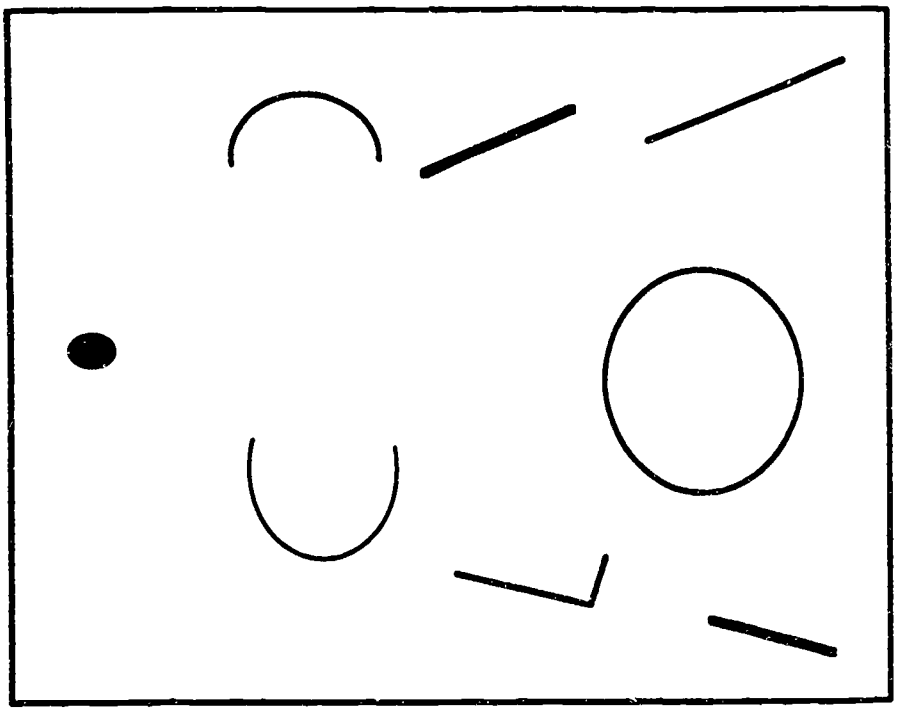

Figure 3
This example of the doodle sheet is 64% of the actual size.

Weighted Items. Various items on the measurement scale were weighted because of differences in complexity. For example, asymmetry is a more advanced design concept than is symmetry. Each item's weight was determined in the following manner. The original three raters for the pilot study were asked to weigh each of the 29 items with a one through five number to designate the level for each item's complexity in relationship to all other items on the measurement scale. The three raters' weighted numbers were averaged to determine a constant score for each item. The constant scores were multiplied by five (the maximum possible number for each item) to determine the cumulative score of 503.30. Refer to Table 1 for a breakdown of each rater's

weighted score, the tabulation of the constant score as derived from the mean, and the possible total score for each item.

Table 1

The determination of the constant score was derived from the mean of all three raters' evaluations of the level of complexity for each item on the measurement scale.

Item	Rater #1	Rater #2	Rater # 3	(derived from mean) Total	Constant	(Constant Score X 5) Cumulative Item Score
1	1	2	1	4	1.33	6.65
2	3	4	3	10	3.33	16.65
3	4	3	2	9	3.00	15.00
4	5	4	3	12	4.00	20.00
5	2	2	2	6	2.00	10.00
6	4	4	4	12	4.00	20.00
7	5	4	4	13	4.33	21.65
8	1	1	2	4	1.33	6.65
9	2	2	3	7	2.33	11.65
10	3	3	2	8	2.67	13.35
11	3	3	3	9	3.00	15.00
12	3	2	3	8	2.67	13.35
13	5	4	4	13	4.33	21.65
14	5	3	3	11	3.67	18.35
15	5	3	4	12	4.00	20.00
16	1	3	3	7	2.33	11.65
17	2	4	4	10	3.33	16.65
18	4	4	4	12	4.00	20.00
19	1	2	2	5	1.67	8.35
20	5	5	5	15	5.00	25.00
21	2	5	5	12	4.00	20.00
22	5	3	4	12	4.00	20.00
23	3	3	3	9	3.00	15.00
24	4	5	4	13	4.33	21.65
25	5	5	5	15	5.00	25.00
26	3	4	5	12	4.00	20.00
27	5	4	5	14	4.67	23.35
28	5	4	5	14	4.67	23.35
29	5	4	5	14	4.67	23.35

Total Cumulative Score = 503.30

Administration and Scoring of the Instrument

The testing sessions took approximately 25 minutes to administer the consent form, the descriptive information section, and the doodle activity sheet. It was necessary to test in several sessions using different advanced classes because of the large number of subjects used. This may have been a limitation of the study because participants may have registered for classes based on requirements, as well as interest. However, administrative concerns would not allow for other options. In the scoring process, the art group doodles were alternated with the English group doodles. The doodles were scored using this ordering system with only the doodle activity sheet and an identifying number of A1 to A55 (for the Art group) or E1 to E54 (for the English group) present on the copies. No other identifying information was available to the second rater and

she was told to disregard the numbering system, for it was only for ordering purposes. The second rater was not aware of the methodology involved in this study.

In order to have a consistent interpretation of the visuals in the text of the revised measurement scale, a training session was given for the second rater. The visuals and scoring procedures were explained in a systematic fashion and practice scoring was done in order to maintain consistent responses for reliability purposes. The second rater was a fine arts college teacher experienced in drawing, painting, and design. This individual had been one of the raters for the pilot study, as well, and was very familiar with the measurement scale.

Data Analysis

Research questions. The first research question was as follows: Will a significant relationship exist between the cumulative total scores of the raters on the measurement scale? This question was investigated using the Pearson Product-Moment Correlation. This was done by using the total weighted cumulative scores for each subject. A comparison was made between the scores of the two raters on the measurement scale for each group. Each rater's mean score and standard deviation were calculated for each group.

The second research question was as follows: Will a significant difference exist between the mean cumulative total score of the raters on the measurement scale for the two groups? This question was investigated using analysis of variance (ANOVA). This was done by meaning the cumulative total scores of the two raters for each subject and comparing these to the specific group classification (art and English) to see if a difference existed. The mean score of the raters and the standard deviation was calculated for each group.

The third research question was as follows: Will evidence of clustering be apparent for items on the measurement scale designed to measure similar traits? In order to determine if an interrelationship among variables existed (a clustering effect), factor analysis was done using PC (principle-components analysis) and varimax orthogonal rotation procedures on the mean scores of the raters on the measurement scale items. Varimax orthogonal rotation allowed the large and small factor loadings to become more highly correlated with single factors.

For the purposes of this study, statistical significance was determined to be at the 95% confidence level ($p < .05$).

Other Analysis

Classification of Doodles. A qualitative evaluation was done to distinguish the various figural features of the doodle drawings through observational method, regarding the similarity and differentness of characteristics, such as line treatment, repeated markings, and subject matter. Themes and motifs were identified and reflected upon in relationship to the conceptual framework of this study. Classifications of doodles were made into various groups. This kind of analysis took into account the investigator's

judgement, based on years of college teaching, in order to classify the various characteristics of the graphic markings.

Findings

Research questions. The first research question was as follows: Will a significant relationship exist between the cumulative total scores of the raters on the measurement scale? The purpose of this question was to determine if the raters scored the measurement scale with consistency in relationship to each other. Did interrater reliability exist? The results of a Pearson Product-Moment Correlation between the total scores for each of the two raters indicated significance. The correlation coefficient was .7593 with a probability of less than .001. Refer to Table 2 for the mean and standard deviation (SD) scores of each group by rater.

Table 2
The mean and the standard deviation scores of each group by rater.

	RATER 1	RATER 2
ART GROUP	Mean = 183.25 SD = 35.22	Mean = 173.44 SD = 41.80
ENGLISH GROUP	Mean = 128.54 SD = 17.38	Mean = 133.98 SD = 16.68

It was determined by these findings that interrater reliability did exist on a significant level. In other words, each rater was consistent with the scoring of the other.

The second research question that was considered was as follows: Will a significant difference exist between the mean cumulative total score of the raters on the measurement scale for the two groups? The purpose of this question was to determine if the raters placed the participants at a performance level that corresponded to the classifications of being in the art or English group. The results of an analysis of variance procedure (ANOVA) indicated a significant difference between the raters' total scores for each group. In other words, participants were placed in either group and the difference in performance of the groups was significantly different. The probability of significance was less

than .001. Refer to Table 3 for the results of the analysis of variance. The combined mean score of both raters for the art group was 178.35 with a standard deviation of 35.18, and the combined mean score of both raters for the English group was 131.26 with a standard deviation of 14.88.

Table 3

An analysis of variance using the mean of the raters' cumulative total scores and the group's classification of art or English.

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF.
MAIN EFFECTS	60409.226	1	60409.226	82.295	0.000
CLASSIFICATION	60409.226	1	60409.226	82.295	0.000
RESIDUAL	78544.285	107	734.059		
TOTAL	138953.511	108	1286.607		

The third research question was as follows: Will evidence of clustering be apparent for items on the measurement scale designed to measure similar traits? The purpose of this analysis was to determine if the measurement scale items clustered together to form specific areas or kinds of spatial traits (called factors). Which items were attributed to specific factors, and were these factors relevant to the purpose of the measurement scale? As a result of factor analysis performed on the scores of the items of the measurement scale, nine factors were identified by this statistical procedure. The correlations between items were attributed to the following nine factors. Refer to Table 4 for a breakdown of the factors (as titled by the investigator) and the items attributed to the factors with the highest factor loadings.

A factor analysis was done on each group separately, the art and the English. It was determined that 77% of the total variance was attributable to these nine factors for the art group and 70.5% for the English group.

FACTOR 1 (Directed Movement) represented nine out of 15 of the most highly weighted items on the measurement scale. In other words, sixty percent of the more advanced concepts were attributed to this factor. It was theorized by the investigator that these highly weighted items were related because of difficulty and were interlinked to each other as more advanced processes. The clustering of these items confirmed this assumption.

FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6	FACTOR 7	FACTOR 8	FACTOR 9
Directed Movement	Pattern	Linear Perspective	Perspective Using Irregular & Consistent Overlapping With Tone	Perspective Using Overlapping of Sequential Shapes With Tone	Perspective Using Overlapping of Different Concepts	Asymmetry for Balance	Consistency	Combination of Symmetry & Asymmetry for Balance
Item 4 .67456	Item 1 .76569	Item 16 .94079	Item 10 .80410	Item 9 .87464	Item 11 .72047	Item 20 .71707	Item 8 .70681	Item 21 .70466
Item 7 .71439	Item 2 .55922	Item 17 .95958	Item 12 .78271	Item 13 .80568	Item 15 .61311		Item 23 .74768	
Item 22 .63541	Item 3 .76162		Item 14 .55326		Item 18 .79879			
Item 24 .81648	Item 5 .67852							
Item 25 .82334	Item 6 .73109							
Item 26 .73218								
Item 27 .62163								
Item 28 .80244								
Item 29 .63637								

Table 4
Rotated Factor Matrix

FACTOR 2 (Pattern) represented all of those items on the measurement scale that were consistent or repetitive concepts in the pattern and tonal sections. These items confirmed the existence of a spatial trait of pattern.

FACTOR 3 (Linear Perspective) represented the only two items on the measurement scale that were linear perspective concepts. The clustering of these items verified this spatial trait.

FACTOR 4 (Perspective Using Irregular and Consistent Overlapping With Tone) represented three items on the measurement scale that dealt with perspective as an overlapping concept. Two of the items were of irregular shapes (one with tonal changes) and one item of consistent shapes (with tonal changes). The use of tone and overlapping are methods of creating depth or perspective in design, and this factor confirmed this relationship. The only irregular shape overlapping items in the perspective section of the measurement scale were represented in this factor.

FACTOR 5 (Perspective Using Overlapping of Sequential Shapes With Tone) represented the only two sequential shape overlapping items (one with tonal changes) in the perspective section of the measurement scale. This factor confirmed the relationship of sequential shapes as another trait of perspective and depth.

FACTOR 6 (Perspective Using Overlapping of Different Concepts) represented the only two overlapping of different shapes items (one with tonal changes) in the perspective section of the measurement scale. Transparency, another perspective item, was also represented in this factor. Transparency can be considered another way of creating depth or perspective by using different concepts in an overlapping manner, only with a see-threw treatment. This factor confirmed the relationship between different spatial concepts as another characteristic of perspective or depth.

FACTOR 7 (Asymmetry) represented the only item on the measurement scale that dealt with asymmetry exclusively. This was part of the balance section, and this factor confirmed the trait of asymmetry as a single spatial concept. The use of asymmetry was theorized by the investigator as representative of the use of extreme abstract placement of space, where balance is a matter of spatial combinations and spaces are played against each other by the use of informal manipulations. This was an advanced concept that was heavily weighted.

FACTOR 8 (Consistency) represented two items on the measurement scale that were consistent concepts, radiation and overlapping of consistent shapes. Movement and flow are regulated by a repetition of visual constancy, and this factor confirmed this relationship.

FACTOR 9 (Combination of Symmetry and Asymmetry for Balance) represented the only item on the measurement scale that dealt with the use of a combination of symmetry and asymmetry for balance. In other words, the use of formal and informal spatial combinations represented a particular kind of manipulation to achieve balance. This factor confirmed that trait.

The results of the factor analysis confirmed that the constructs on which the measurement scale was built were representative of specific traits that

allowed for various kinds of manipulation of space, either through the use of pattern, variation (large, medium, or small use of shapes which exercise sequence, irregularity, or overlapping), gradation (tonal changes), perspective and depth, balance (through the use of formal or informal arrangements of space), or directional movement (requiring the thoughtful relationship of parts).

Cutoff Scores. The measurement scale was determined to be a criterion-referenced test. Therefore the need presented itself to evaluate the subjects' performances based on levels of proficiency, not on the total group mean score. A standard for performance was set by the investigator, and the judgement for the cutoff score levels was based on a reasonable and subjective approach (Millman, 1973). The approach specified three levels of spatial functioning, states, or categories. They were mastery level (advanced), partial-mastery level (intermediate), and non-mastery level (remedial).

The reason for setting cutoff scores was to accommodate a statistical framework based on criterion scores (or fixed standards), instead of measuring performance based on a distribution of scores of the total group. It must be realized that an examinee's true mastery level is a probabilistic situation and that misclassifications can occur. However, this is also true of other evaluation procedures. It must also be recognized that an individual's performance level on the doodle activity may be influenced by many factors such as exposure, artistic training, genetics and predisposition, manual dexterity, perceptual awareness, or creative imagination.

The measurement scale had 29 items. The two raters' scores were averaged for each item. The weighted scores for each item were multiplied by the averaged raters' scores and totaled for an overall score (refer to "weighted Item" section of this paper). Then the cumulative total score was used to place the subjects in one of the three levels of mastery. The art group (based on ranked total scores) was considered to be the master group and was used to set the standard performance level for the English group, as well as for any other groups that may be subsequently tested. An English group examinee must have scored at least as well as the bottom 10% of the art group scores to be considered partial-mastery level. A mastery level classification required a score of at least 85% or above of the art group. Frequency distributions were calculated to determine the percentage of English subjects that fell within each group classification. Refer to Figure 4 for a visual clarification of level percentages and group classifications.

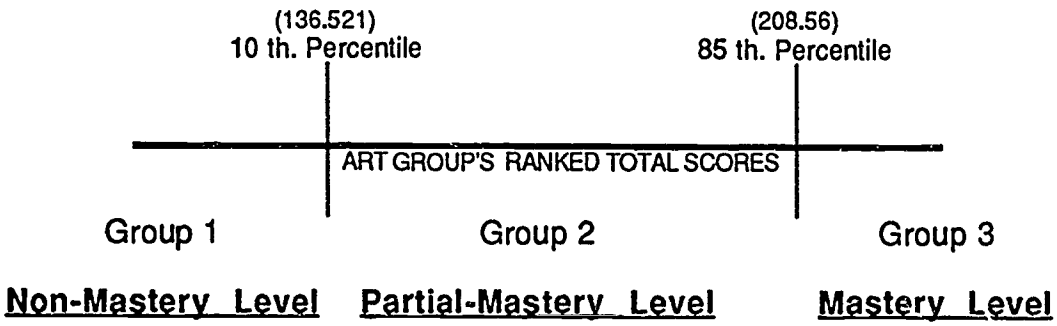

Figure 4
Mastery levels based on the art group's ranked total scores.

The cutoff score at the 10th. percentile of the art group 's ranked scores was 136.521. The cutoff score at the 85th. percentile was 208.56. Thirty-seven subjects (69%) of the English group fell into group 1, the non-mastery level category, and 17 subjects (31%) fell into group 2, the partial-mastery level category. No English subjects fell into the mastery level category. The closest score of the English group to the mastery level cutoff score was 186.82, almost 22 points below the mastery level cuttoff score of 208.56.

Five subjects (9%) of the art group fell into the non-mastery level category, 42 subjects (76%) fell into the partial-mastery level category, and 8 subjects (15%) fell into the mastery level category.

Classification of Doodles. A qualitative evaluation was done to distinguish the various figural features of the doodle drawings through observational method, regarding the similarity and differentness of characteristics, such as line treatment, repeated markings, and subject matter. Themes and motifs were identified. The purpose of this classification system was to note whether or not the participants fell into any particular pattern of classifications. The doodle drawings were found to fall into eight categories (refer to Appendix B for at least two doodle examples of each category). They were labeled and defined in the following ways:

(1) separate motif category: The individual drew around the signal lines as separate motifs. There was no connecting of signal lines to each other to create visual flow. Thirty-three (33) participants fell into this category. Twenty-four (24) participants (73 %) were from the English group, and 9 participants (27 %) were from the art group.

(2) confined to signal line area category: The drawing was confined to the configuration of the signal line area. Twenty (20) participants fell into this category. Twelve (12)

participants (60 %) were from the English group, and eight (8) participants (40 %) were from the art group.

(3) visually directed movement category: In varying degrees of approaches, these drawings exhibited great fluidity of figural manipulation and visually directed control. Twenty (20) participants fell into this category. Eighteen (18) participants (90 %) were from the art group, and two (2) participants (10 %) were from the English group. Of the two English participants, one had a BFA and the other had had art training.

(4) meandering category: These drawings exhibited a freedom and spontaneity of visual movement of a meandering nature. The various concepts were not well connected nor defined and exhibited a child-like approach to drawing. Thirteen (13) participants fell into this group. Nine (9) participants (69 %) were from the art group, and four (4) participants (31 %) were from the English group.

(5) symbolism category: The content matter of these drawings showed that the participants attempted to make an abstract expression represent something of realism, such as a sun, a tube of paint, or a person. All eight (8) participants in this category were from the English group.

(6) loosely shaded treatment category: This category represented a very loosely shaded line treatment as form, shape, and visual movement. Overlapping of lines with a massive, spontaneous flavor characterized these drawings. The seven (7) participants in this category were all from the art group.

(7) linear perspective category: Drawn linear perspective characterized the doodles of this category. Five (5) participants fell into this category. Four (4) participants (80 %) were from the art group, and one (1) participant (20%) was from the English group. All of the participants were male.

(8) denial of signal lines category: This category was characterized by three (3) drawings where the participants drew as if the signal lines did not exist or were treated with little visual value, as if they were non-existent. All participants were from the English group.

Four of the above eight categories, numbers three (visually directed movement), four (meandering), six (loosely shaded treatment), and seven (linear perspective), were considered to be spatial because they utilized basic design principles, the elements as found on the measurement scale. Thirty-eight (38) participants (69 %) of the art group fell into these four classifications.

Four of the above eight categories, numbers one (separate motif), two (confined to signal line area), five (symbolism), and eight (denial of signal line), were considered non-spatial because they did not correspond to the design elements as governing forces. Forty-seven (47) participants (87 %) of the English group fell into these classifications.

It was concluded from the classification of the doodles that certain features were characteristic of spatial thinking. These features represented very specific types of spatial elements and the use of these features designated mastery level as indicated by the placement of the participants from the two groups.

Summary and Conclusions

The results of this study indicated that significant interrater reliability existed on the measurement scale. The results also indicated that the master group (art subjects) and the non-master group (English subjects) had significant differences on scores. There was a difference between these two groups in regard to the measurement scale, thus indicating that the art subjects scored higher due to their mastery level. Based on the conceptual framework of this study, it can be concluded that the measurement scale measured what it was intended to measure, that of spatial reasoning based on figural elements from design, and that the scoring was reliable. It can also be concluded that spatial reasoning is highly related to figural structures that allow for the manipulation of abstract imagery as a mental reasoning faculty. This was evident in the results of the doodle classifications, for the participants of the two groups separated into categories that designated spatial or non-spatial characteristics based on figural knowledge.

The concept of doodling as a way of understanding spatial thinking in process comes from the field of applied visual arts and is revolutionary in nature. The results of this study signified that doodling can be used as a concrete expression of a thinking process and be measured on a quantitative level. It was also concluded that certain characteristics of the doodles significantly represented either the master group or the non-master group, thus confirming the difference between the groups on a qualitative level.

The findings of this study provided a way to evaluate an individual's thinking process in regard to figural structures that represent spatial reasoning abilities. This thinking style does not conform to the traditionally thought of ways of reasoning. However, it is obvious that it does exist, and that concern for this kind of thinking process as a legitimate form of intelligence is necessary in order to understand and to teach various individuals. Learning strategies and teaching methodologies can and should take into account this thinking style when exploring the full range of human potentialities. The consequences of not recognizing this reasoning ability was evidenced by a detailed and lengthy account of one teenage boy's life. A local newspaper carried an analysis of Morgan's life. It was believed that he committed suicide at seventeen years of age because he had no options for expressing his unique thinking habits (Millard, 1988, May 22). You see, Morgan was apparently spatial and no one knew how to evaluate his abilities, so he failed classes and he suffered from auditory and verbal difficulty (but continued to act out his inner visions). It was reported that he gave up because the world did not seem to understand his reasoning as expressed in his abilities to perform as a clown in front of audiences, as an expert unicyclist, and as a master of fantasy. He was uniquely expressive in a non-verbal way and became disfunctional because of a lack of

self-esteem created by an uninformed educational system. Lack of educational response to this individual and others like him is a crime. This kind of research on spatial reasoning can contribute to the educational field a better understanding of the unseen imagery that exists in the mind as a reasoning tool. This kind of thinking is governed by the language of space and is concretized by action, such as a doodle.

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STYLISTIC INDEPENDENCE IN ART: DOODLING AS AN INDICATOR OF IDIOSYNCRATIC EXPRESSIVENESS

Stylistic Independence in Art: Doodling as an Indicator of Idiosyncratic Expressiveness

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This paper presents a conceptual framework that characterizes doodle activity in adults as a consistency of figural relationships resulting in an artistic style. This concept is based on an observational study, exploratory in nature, of community college visual art students, and it was theorized by the investigator that a lifelong developmental process of graphic activity exists. The results revealed that the practice of graphic activity produces an individual artistic perspective, expressed in consistent figural markings, that links the activity of doodling to artistic development.

The intention of this paper is to lay the foundation for regarding artistic expressiveness as unique to each individual. It is conceptualized by the investigator that the activity of doodling is representative of an unfolding thought process, characterized by a progressive development of figural thinking from childhood to adulthood, that links individual artistic perspective to artistic style in adults. The conceptual framework presented in this paper explores graphic activity from child art to the graphic activity of doodling or scribbling in adults. A development of characteristic lines, markings, and features exist and signify the expression of idiosyncratic behavior or stylistic independence in art.

The various stages of artistic development involve a maturation process from childhood to adulthood. These various stages, including child art, pre-adolescent years, adolescence, and adult awareness, form an inner perspective that is manifested in the activity of doodling. The visual form of doodling permits an examination of the thinking process (La Pierre, 1987) in relationship to other visual expressions from the same individual.

The approach to this observational study is a result of the investigator's experience of teaching basic design to adults. It is an outgrowth of an interest to aid adults in developing an individual artistic direction or style based on their own experiences and perspectives. As a result, students' doodle activities were compared to final projects in design classes over a five year teaching period. The analysis of this study is based on direct observation by comparing similarities or differences in markings. Slides of various students' works were taken to validate the findings. The investigator theorized that the activity of doodling is representative of an unfolding thought process (one that is characterized by the progressive development of figural thinking patterns) that links individual artistic perspective to artistic style in adults. Therefore it was assumed that common characteristics that are idiosyncratic to each individual

should be expressed in both a doodle drawing and a design project when they are compared, regardless of subject matter.

A Conceptual Framework

Children's drawings, scribbles, and doodles (graphic activity) suggest that the individual possesses characteristic thinking habits that are unique to his or her own artistic expressiveness (Arnheim, 1974; Gardner, 1980; Kellogg, 1969; Winner, 1982). Basic features of doodle or scribble markings are repeated and become characteristic of the individual artist. Kellogg (1969) emphasizes this point by stating the significance of child art. She says:

> It seems to me that the inspired artist actually utilizes childhood's self-taught esthetic forms and releases energy for art similar to that released in childhood. He does this with controls learned through great discipline, acquired with age and practice. The artist's 'self-regulated regression' returns to scribblings but is not truly regressive if the purpose of the return is the utilization of scribblings' esthetic essence in an adult manner. The scribbles and the prepictorials of child art are the *prima materia* of all art. The use to which they are put is determined by the emotional and artistic

The development of graphic activity can be categorized into several stages that all normal human beings tend to experience through growth. Making scribble markings on paper (or on walls, or in the dirt) begins at about one and a half years of age. Scribbles are very random at this stage and later develop into the employment of more definite shapes (Edwards, 1979). Child art, in relationship to various kinds of shapes and sensory-motor movements, can be classified as arising from a developmental process, as for example the circular or circle form (Edwards, 1979: Kellogg, 1969). Extensive work was done by Kellogg (1969) in the analyzing and categorizing of hundreds of children's drawings. Kellogg's conclusion was that artistic development was a quality that was indigenous to all children's art; the process of making a line or a circle was common to all normal children. The expressive quality of graphic activity allowed for purposeful growth.

Betty Edwards (1979) characterizes children's art as becoming increasingly more complex with age, reflecting a child's growing consciousness of perceptions in the world. Edwards states that children are not only aware of basic shapes, but details as well. "These favorite ways to draw various parts of the image eventually become embedded in the memory and are remarkably stable over time" (p. 66). In adults, Edwards (1986) calls this the "making of telling marks," a visual identification of uniquessness such as a signature.

As graphic activity progressively develops in the child, feelings and stories are portrayed by the drawings. Symbols develop as representations of concepts (Edwards, 1979; Gardner, 1980; Kellogg, 1969). For example, a sun is often represented as a circle with radiating lines. Composition is balanced and forms are arranged as integral elements. Edwards (1979) explains it the following way:

> Children seem to start out with a nearly perfect sense of composition, which they often lose during adolescence and regain only through laborious study. I believe that the reason may be that older children concentrate their perceptions on separate objects existing in an undifferentiated space, whereas young children construct a self-contained conceptual world bounded by the paper's edges. For older children, however,

With maturity, about 9 to 11 years of age, comes an exploration of greater graphic complexity of designs and the thirst for realism. Children decide at these ages whether they can or cannot draw effectively, presumably based on the degree to which their drawings appear to be realistically executed (Edwards, 1979; Gardner, 1980). For most individuals, however, the development of drawing and graphic skills stops at about the age of puberty because mastery is not achieved or acquired through learning. Gardner (1980) regards the adolescent years of realistic drawing as a necessary step in order to procure artistic mastery through practice and technical understanding. The development of technical skill is prerequisite to learning intentional shape placement and aesthetic understanding.

In reviewing modern adult learning theory, Lindeman (as cited in Knowles, 1984) identifies several key assumptions. One of these assumptions is based on the concept that individual differences increase with age among people. An adult learner analyzes experiences in relationship to his or her own quest for knowledge to express the self. This quest is characterized as a more self-directed process. It is this aspect of learning by adults that enables them to discover idiosyncratic expressiveness from their own knowledge base. Adolescence is a stage of artistic conformity and does not allow the individual to stand out. However, adulthood is a stage of self-evaluation and individual development of perspective. If for some reason, either through education, circumstances, or personality, the individual has stopped developing artistically, adulthood can allow the individual to restore an already unique self through "self-actualization" based on his or her own knowledge base or lifelong learning experience. The process becomes a discovery method that is built on the desire to know and to enrich the self, an integration within the context of living. In Gardner's view (1980), "...in any effort to locate the seeds of innovative creation we cannot do better than to begin by revisiting the earliest moment of development. For one thing, it is the youngest child who proceeds most identifiably on the basis of his own inherent tendencies and who is least influenced (and hence least molded) by his surrounding culture." (p. 260)

If a teacher approaches the educating of adults as one would children who need more structure, the results may be frustrating for the student and a continued lack of self-evaluation in discovering the student's own unique artistic style. Without an avenue to express the quality of artistic self-development, frustration, anger, and eventual dislike for creating can develop because the individual thinks it cannot be done. Duncan (as cited in Cuzzort & King, 1980) believes that a failure to reach goals of expressing an ideal concept induces a sense of incompetence.

Doerter (as cited in Eisner, 1972) found that the vast majority of college students were influenced by their instructor's style during the course of a semester of painting class. The conclusion was that a teacher's attitude can influence idiosyncratic expressiveness. In most instances the chance does not occur for students to develop a vitally unique approach to their own work. Because of the use of traditional teaching methods, the student is taught to be aware of how someone else visualizes the use and practice of art principles. The basic principles become something extrinsic or outside of the student's own work, outside of the student's own sense of creative development, vague intellectual concepts that only teachers can understand or that experience will eventually teach, so the student tends to believe. Thus, the present day college art student is trained in the fundamentals of art appreciation on the level of the observer instead of the doer. Artistic development is not just the acquisiton of skills and techniques in order to imitate good designing. Rather, it is the developing of a mind to achieve individually inspiring work that will express the conceptualization of the artist as self-visualized.

In summary, it is determined that graphic activity is a developmental process in children and that adolescent drawing activity develops into a stage of artistic conformity. It is assumed that the adult years can result in a rediscovery of basic figural concepts that are characteristic of each individual's expressiveness because adulthood is a self-directed period of learning.

Method

The following components comprise the methods section of this study: (1) the description of the subjects; (2) the procedure of the study; and (3) the investigator's method of teaching basic design.

Subjects. The data in this study were gathered by the investigator while teaching basic design at the community college level. The approximate number of students that participated in this observational study was 60 over a period of five years, and the ages varied from 18 to 65 years with an average age of 28 years. The students had not taken any basic design courses before taking the investigator's beginning class, which was part of the required art curriculum. However, many of the students were previous art students, either in high school or adult education classes. The investigator's design class sessions ran for 15 weeks, meeting twice a week for three hours each session. The classes were considered art studio classes, and students worked on projects while in class.

Procedure. Each student was given a large piece of white butcher paper (approximately 36" x 36") on the first day of class. The students were asked to "doodle" or "play" with a large black felt-tip pen as if they were talking on the phone. They were asked to concern themselves only with abstract ideas and designs and not with representational or recognizable shapes or items. At the end of a five minute period, the students were asked to write their names on the doodle drawings, and the drawings were then placed in the investigator's office and not referred to until the last day of class when they were compared to the final projects.

The assignment for the final project was to combine two or three basic design principles, using only abstract shapes. These principles were covered in class during the course of the 15 weeks and included the use of line, pattern, variation, gradation, focal point, depth, balance, flow and movement, and color. On the last day of class the students compared their doodle drawings to their final abstract design projects to see if a relationship existed between a free drawing task (such as doodling) and a consciously directed task (such as an art project with specific goals).

Teaching Method. The investigator's method of teaching centered on the principles of basic design as a tool to enhance a thinking process. The ability to manipulate design elements fostered freedom for the user to conceptualize an infinite number of possible visual solutions. The focus of this approach was to allow the students to remain independent of the investigator's artistic style and the artistic influence of others (such as the art world of critics and galleries that often set standards for creating) by concentrating on the skill to create as an individual. The concept of space, manipulating its development, its visual purpose and movement, and its aesthetic formations, was a critical aspect of the course content.

It was anticipated that this method of teaching would allow the students to develop their own natural direction and artistic style and to use design as a tool for this purpose. Each student was encouraged verbally to seek an individual artistic approach and to utilize the design principles to present that approach on a visual level.

Each design project (there were 10 to 12 projects per course) was critiqued in class and treated as a positive learning experience for everyone. The critiquing process was defined as evaluative judgement based on the use of design principles. The investigator encouraged disagreement and expected each student to defend his or her design approach. During the critiquing periods, explanations and demonstrations were given by the investigator in regard to each piece and how to improve the use of design principles within the composition. Artistic style was never discussed. The emphasis was placed on the concept that each student could design effectively and achieve repeated success, if they desired to do so. The utilization of design principles as a thoughtful and purposeful process, instead of a chance happening, was stressed. A more detailed report of this method and its analysis based on design principles can be found in La Pierre (1983).

Analysis

An attempt was made to distinguish the various figural features of both the doodle activity and the final project and to compare these pieces through observational method for similarity or differentness of characteristics, such as line treatment and various repeated markings. This kind of analysis procedure took into account the investigator's judgement, based on years of college teaching, in order to classify the various characteristics of the graphic markings. Themes or motifs were identified and reflected upon in relationship to the

conceptual framework to determine if the assumptions made could be supported.

Findings

When the doodle drawings were compared to the final design projects, it was evident that the same individual had executed both pieces. The student's work had similar figural features in both pieces, and there appeared to be a likeness or similarity of figural features between the two pieces in almost every case. Figures 1 to 10 show the comparison between the doodles and the final projects of five students' works. Although the final projects were completed in color, the figural essence (as identified by themes, motifs, line treatment, or various repeated markings) was the basis of the comparisons made.

As shown in Figure 1, the doodle activity used a circular motif with the visual movement of the shapes controlled by a dark, medium, and light line treatment (see Figure 1). Small, medium, and large shapes were used in a progressively circuitous manner. In the final project as shown in Figure 2, similar use of the same concepts as in the doodle can be seen (see Figure 2). There was an obvious recurrence of the use of the same theme in both pieces.

Figure 1

Doodle Activity

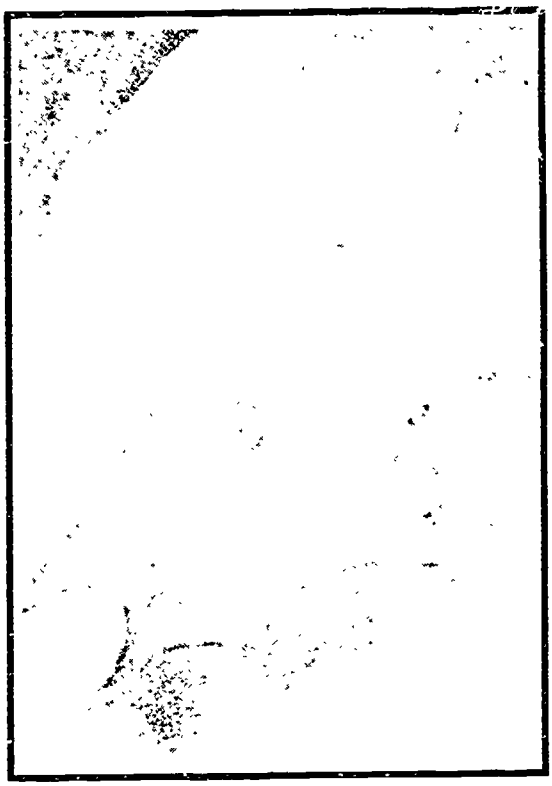

Figure 2

Final Project

In Figure 3, the doodle activity concentrated on an open-spaced design (see Figure 3). The various parts were made up of features such as radiation, a ear effect coupled with pattern, and the repetition of small, medium, and rge shapes used in a progressive manner. In the final project, Figure 4, the representational subject matter was handled in a stylized fashion, using the same concepts that appeared in the doodle drawing except that the shapes in the final project were connected and not separated out into various motifs (see Figure 4).

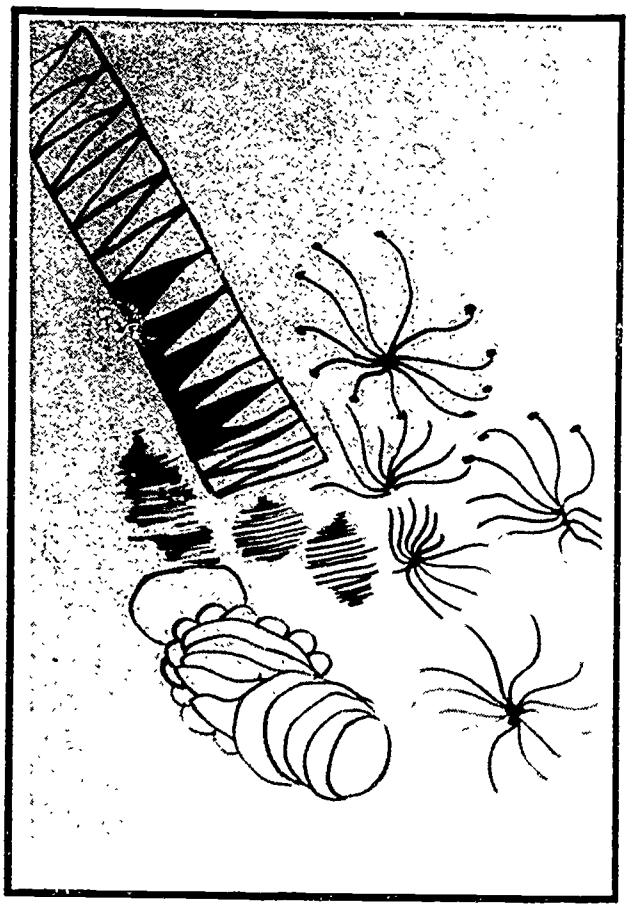

Figure 3

Doodle Activity

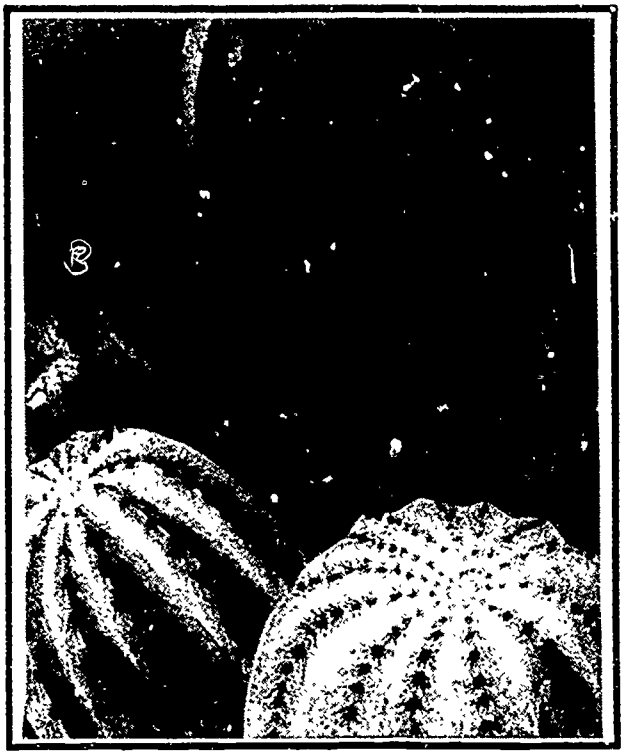

Figure 4

Final Project

In the doodle activity of Figure 5, the basic element or motif was the use of angular shapes built one on top of another in a linear manner (see Figure 5). Lots of activity characterized this doodle. There was a repetitious quality to the design created by angular build-ups that lack an obvious variation or exaggeration in the sizes of the shapes. The final project, as observed in Figure 6, was characterized by the same theme as in the doodle, the building of angular shapes or blocks and the overlapping of these shapes in a linear fashion (see Figure 6). Instead of a consistently repetitive design, as seen in the doodle, there appeared to have been more of a use of small, medium, and large shapes and dark, medium, and light shapes--concepts that are basic to good designing in order to create movement and flow to direct the viewer's eye. In both the doodle and the final project, the individual allowed the shapes to run off the edge of the paper. This represented a consistent factor found in both pieces.

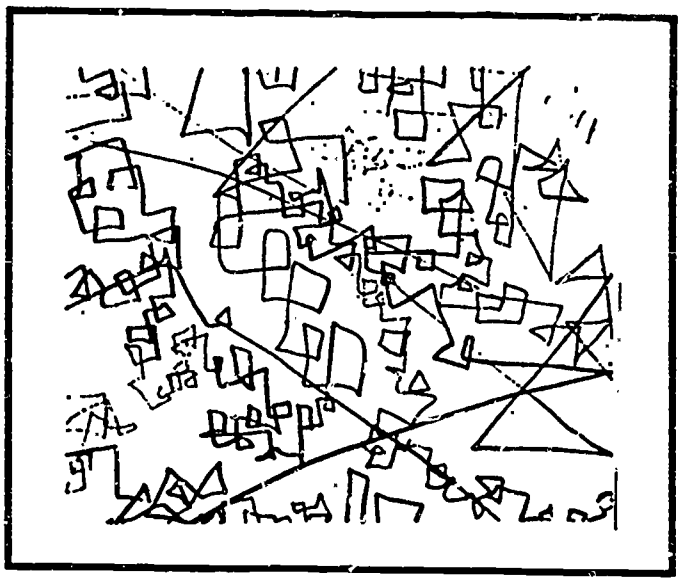

Figure 5

Doodle Activity

Figure 6

Final Project

In Figure 7, the doodle activity was confined to a small portion of the paper (see Figure 7). The use of radiation characterized the theme with a half-enclosed circle as the motif. There was a use of small, medium, and large shapes which pushed the design out, creating visual flow. There was also the use of dark, medium, and light lines. In Figure 8, the final project, radiation was again the theme (see Figure 8). Small, medium, and large shapes were dominant forces that pushed the design out visually. The final project was recurrent of the doodle activity's figural features, but represented a more encapsulated version of the theme.

Figure 7

Doodle Activity

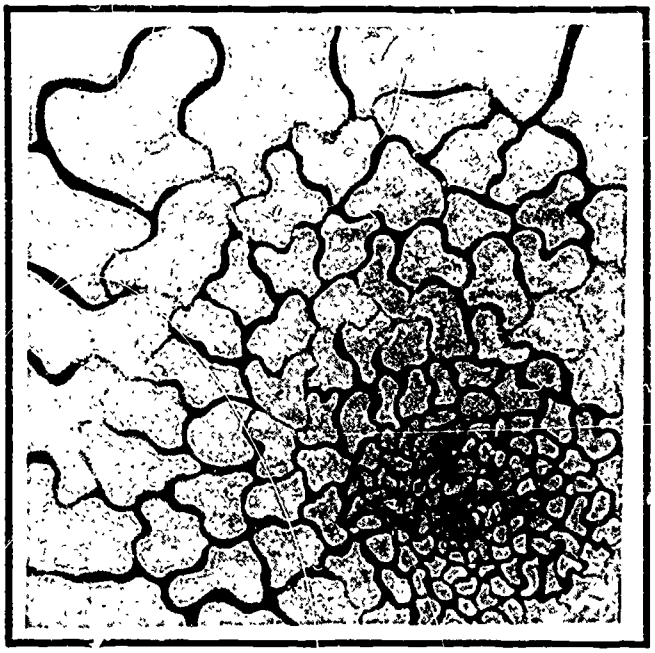

Figure 8

Final Project

In Figure 9, the doodle activity was based on a repetition of one idea or theme, a leaf form (see Figure 9). The shapes were placed next to each other, creating a static arrangement which limited flow or directional movement. The shapes appeared to be sitting on a background and not related to it or to each other except by proximity. In the final project (see Figure 10) the same leaf shape was used. This time the shapes related more to each other than in the doodle because of the use of small, medium, and large shapes and a focal point or area of interest, all of which created flow and directional movement. The shapes also overlapped each other creating a sense of depth or perspective. The same theme was consistently used in both the doodle and the final project.

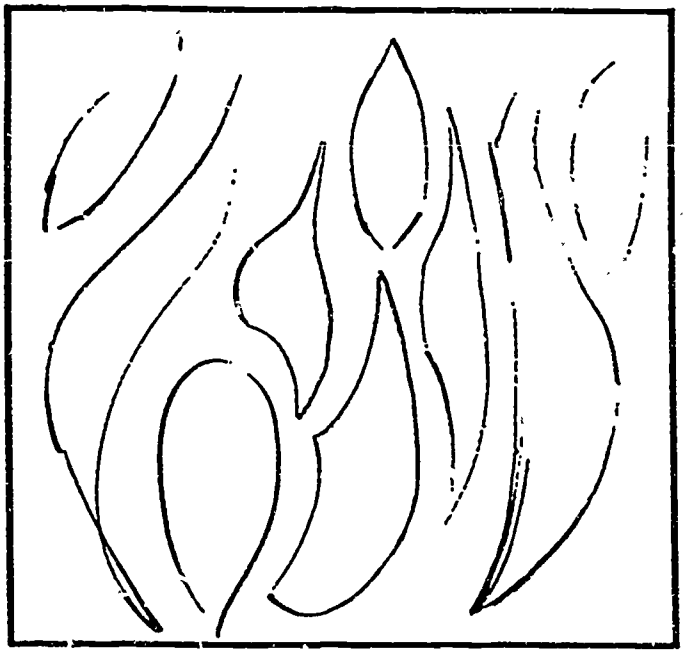

Figure 9

Doodle Activity

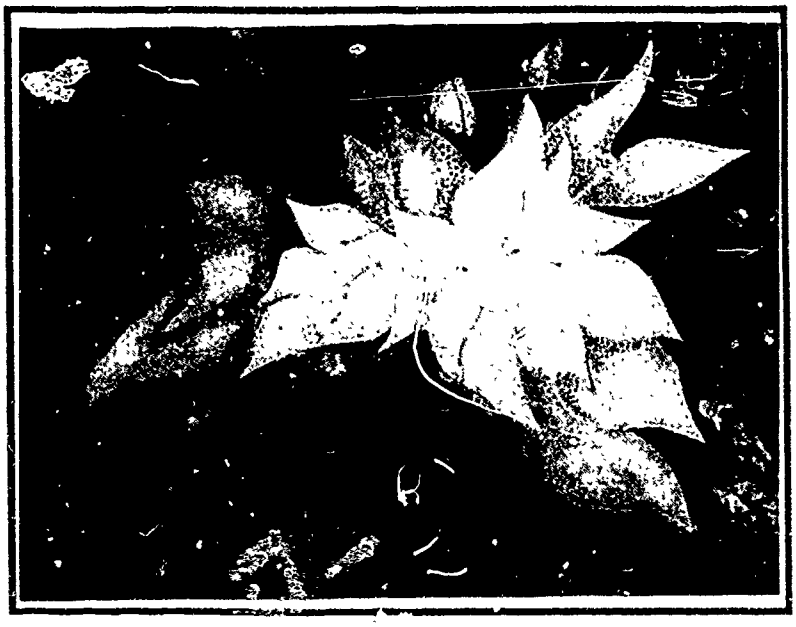

Figure 10

Final Project

Discussion

It was concluded that there existed common figural features, such as themes or motifs, expressed in doodle form and in other visual forms created by the same individual which formulated what is known as artistic style or idiosyncratic expressiveness. This study indicated that if adults could learn to manipulate design elements as basic tools for creating visual concepts, an artistic style would emerge--a style that was as natural to them as it was characteristic of children's graphic work. It was concluded that adults did possess a sense of artistic direction that was unique to them and that was based on learning to acquire artistic techniques, tools, or skills (as found in the elements of design) for the purpose of enhancing and focusing visual expressiveness to direct a thinking process.

The significance of this conceptual study was that individual expressiveness was an important part of artistic development. Visual expressiveness was uniquely characteristic to the individual and was evidenced by the use of common graphic markings.

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APPENDICES

APPENDIX A

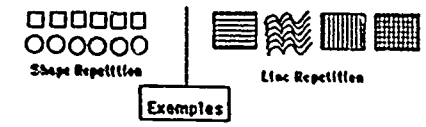
MEASUREMENT SCALE FOR THE SPATIAL MANIPULATION OF ABSTRACT MENTAL IMAGERY

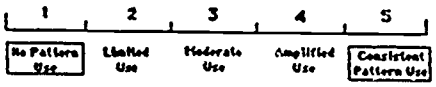
MEASUREMENT SCALE FOR THE SPATIAL MANIPULATION OF ABSTRACT MENTAL IMAGERY

By Sharon D. La Piana, Ph.D.

I.) Pattern Use:

1) Repetition of shape or line (pattern-consistent sizes)

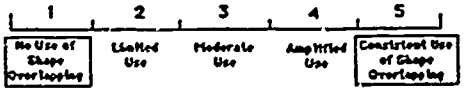




2) Combination of patterns: shape or line (consistent sizes)

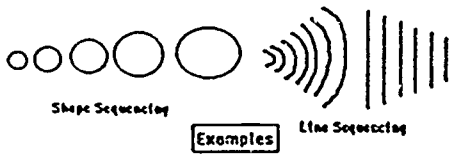
II.) Use of Perspective and Depth:

8) Overlapping of Consistent shapes

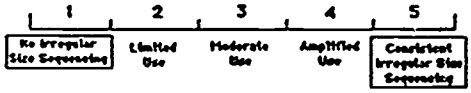


a.) Sequential use of large, medium, small shapes or lines (Variation):

3) Sequential repetition of shape or line

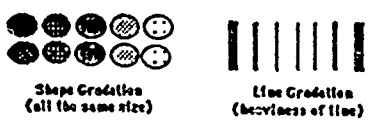


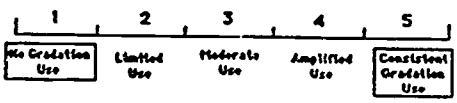
4) Irregular size sequencing of shape or line



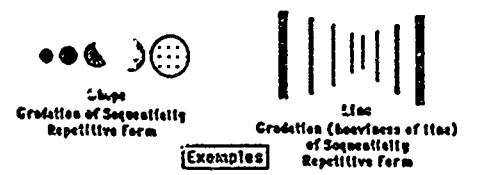
b.) Tonal Changes: dark, medium, light (Gradation):

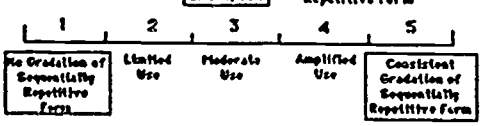
5) Gradation of shape or line (shading of consistently repetitive forms)



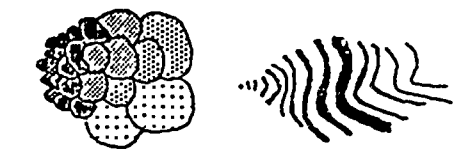


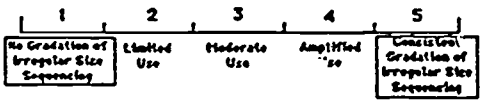
6) Gradation of shape or line (shading of sequentially repetitive forms)





7) Gradation of shape or line (shading of irregular size sequencing)





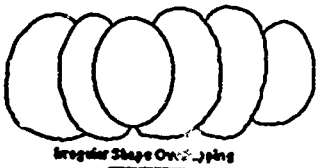
9) Overlapping of sequential shapes

Sequential Shape Overlapping

Examples

1	2	3	4	5
No Use of Sequential Shape Overlapping	Limited Use	Moderate Use	Amplified Use	Consistent Use of Sequential Shape Overlapping

10) Overlapping of irregular shapes

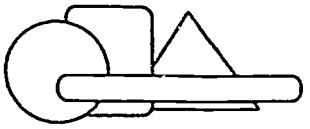


Irregular Shape Overlapping

Example

1	2	3	4	5
No Use of Irregular Shape Overlapping	Limited Use	Moderate Use	Amplified Use	Consistent Use of Irregular Shape Overlapping

11) Overlapping of different shapes

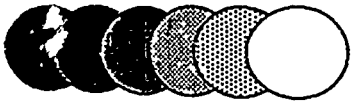


Different Shapes Overlapping

Example

1	2	3	4	5
No Use of Different Shapes Overlapping	Limited Use	Moderate Use	Amplified Use	Consistent Use of Different Shapes Overlapping

12) Overlapping of consistent shapes with gradation



Consistent Shapes with Gradation Overlapping

Example

1	2	3	4	5
No Use of Gradation With Consistent Shape Overlapping	Limited Use	Moderate Use	Amplified Use	Consistent Use of Gradation With Consistent Shape Overlapping

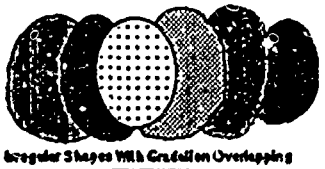
13) Overlapping of sequential shapes with gradation

Sequential Shapes With Gradation Overlapping

Examples

1	2	3	4	5
No Use of Sequential Shapes With Gradation Overlapping	Limited Use	Moderate Use	Amplified Use	Consistent Use of Sequential Shapes With Gradation Overlapping

14) Overlapping of irregular shapes with gradation

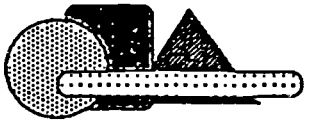


Irregular Shapes With Gradation Overlapping

Example

1	2	3	4	5
No Use of Irregular Shapes With Gradation Overlapping	Limited Use	Moderate Use	Amplified Use	Consistent Use of Irregular Shapes With Gradation Overlapping

15) Overlapping of different shapes with gradation

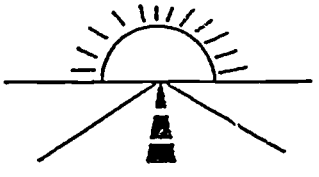


Different Shapes With Gradation Overlapping

Example

1	2	3	4	5
No Use of Different Shapes With Gradation Overlapping	Limited Use	Moderate Use	Amplified Use	Consistent Use of Different Shapes With Gradation Overlapping

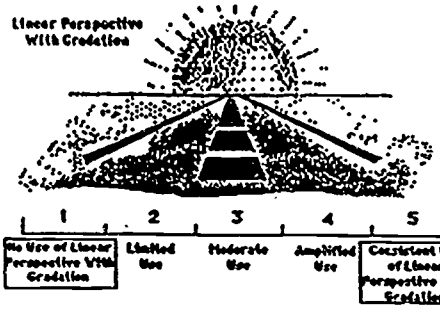
16) Use of linear perspective



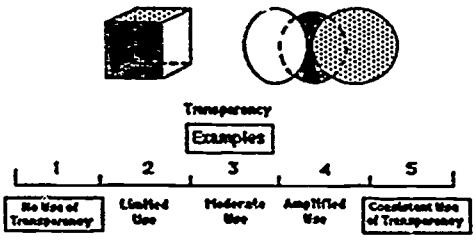
Linear Perspective

1	2	3	4	5
No Use of Linear Perspective	Limited Use	Moderate Use	Amplified Use	Consistent Use of Linear Perspective

17) Use of linear perspective with gradation

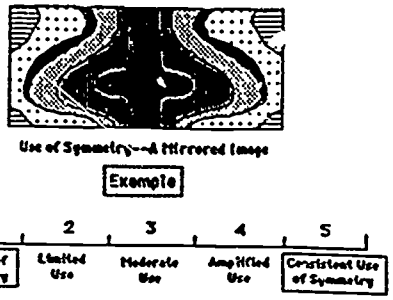


18) Transparency

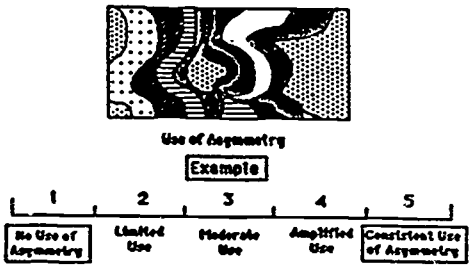


III.) Balance:

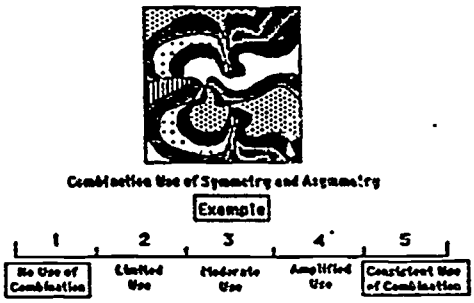
19) Use of symmetry



20) Use of asymmetry

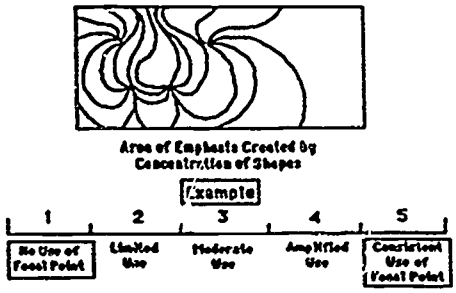


21) Combination use of symmetry and asymmetry

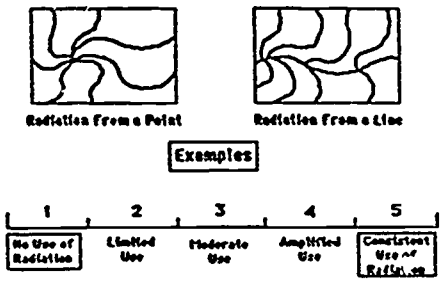


IV.) Focal Point or Area of Emphasis:

22) Use of a specific focal point or area of emphasis (concentration of shapes, lines, shading, or converging or diverging vantage point)

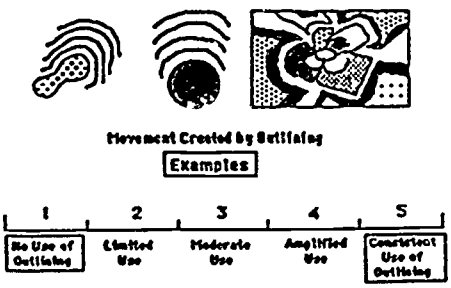


23) Use of radiation from a point or line

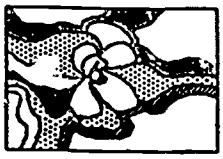


V.) Rhythm, Flow, Directional Movement:

24) Use of outlining shapes to create movement



25) Use of stretching, enhancing, or exaggerating



Use Stretching, Enhancing, or Exaggerating of Shapes

Example

1	2	3	4	5
No Use of Shape Stretching	Limited Use	Moderate Use	Amplified Use	Consistent Use of Shape Stretching

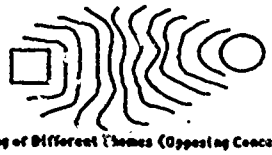
26) Line creating shape

Line Creating Shape

Example

1	2	3	4	5
No Use of Line Creating Shape	Limited Use	Moderate Use	Amplified Use	Consistent Use of Line Creating Shape

27) Blending of different themes (opposing concepts)

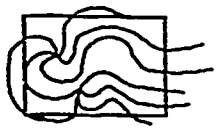


Blending of Different Themes (Opposing Concepts)

Example

1	2	3	4	5
No Use of the Blending of Various Themes	Limited Use	Moderate Use	Amplified Use	Consistent Use of the Blending of Various Themes

28) Intentionally directed movement (as opposed to serendipity)--contact with edges or sides of the drawing box area

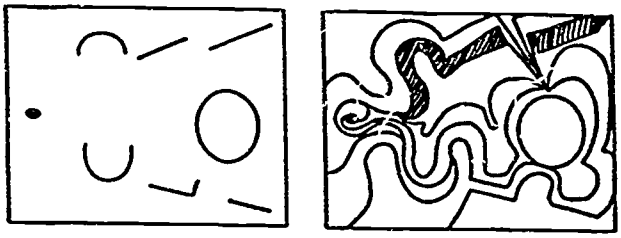


Intentionally Directed Movement

Example

1	2	3	4	5
No Use of Intentional Movement	Limited Use	Moderate Use	Amplified Use	Consistent Use of Intentional Movement

29) Connecting of original starter lines



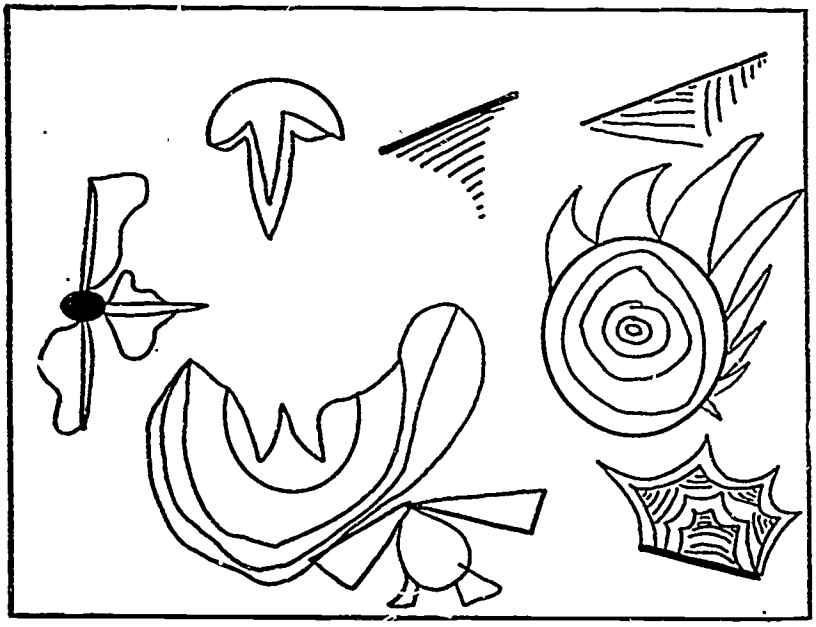
Connecting Starter Lines

Examples

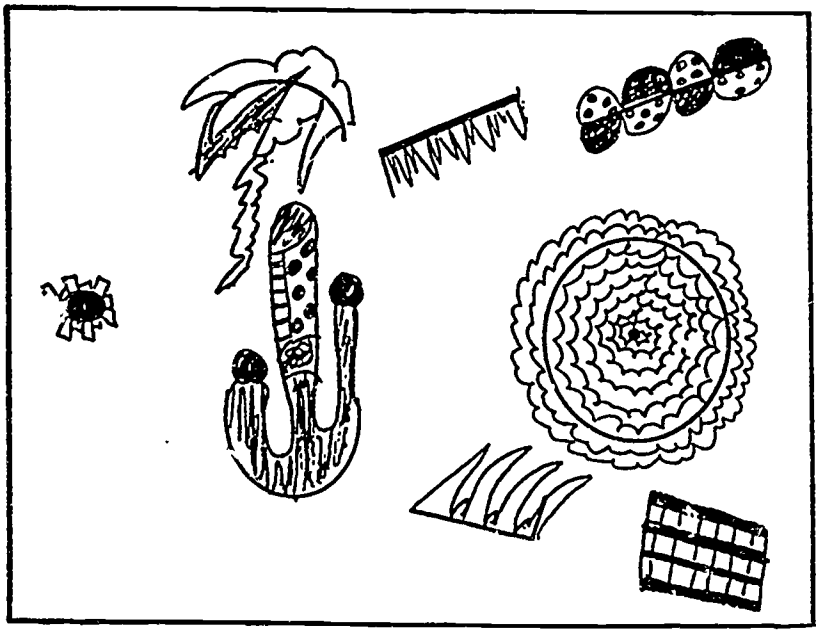
1	2	3	4	5
No Use of Connecting Starter Lines	Limited Use	Moderate Use	Amplified Use	Consistent Use of Connecting Starter Lines

APPENDIX B

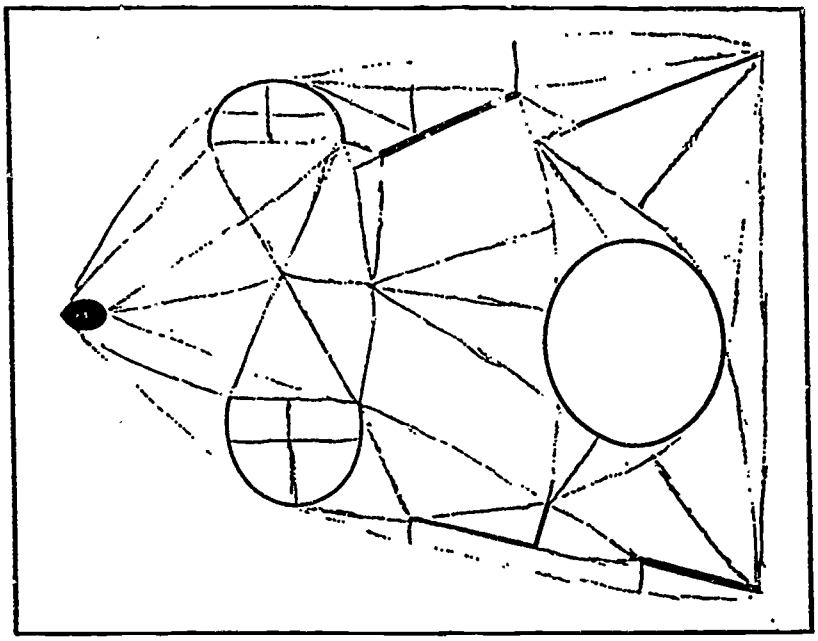
CLASSIFICATION OF DOODLES



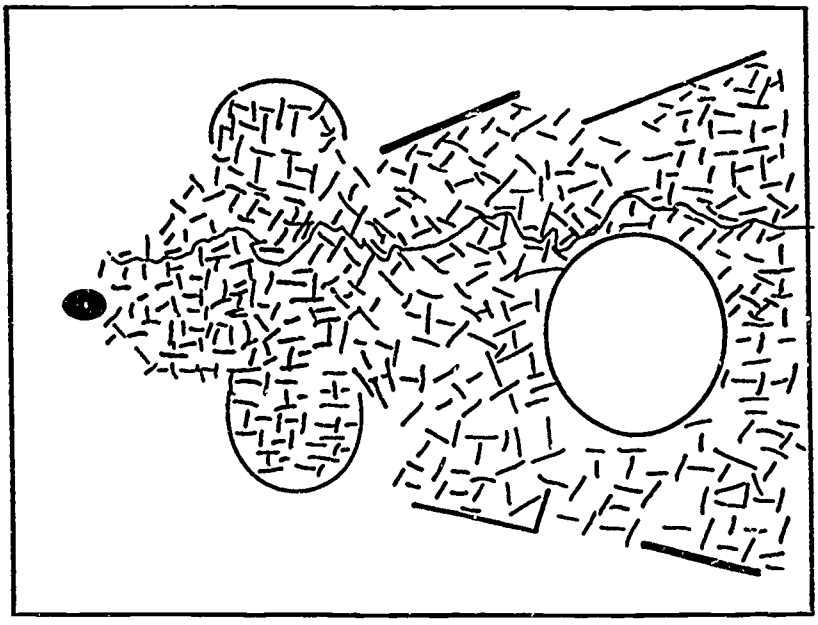
Category 1: Separate Motif



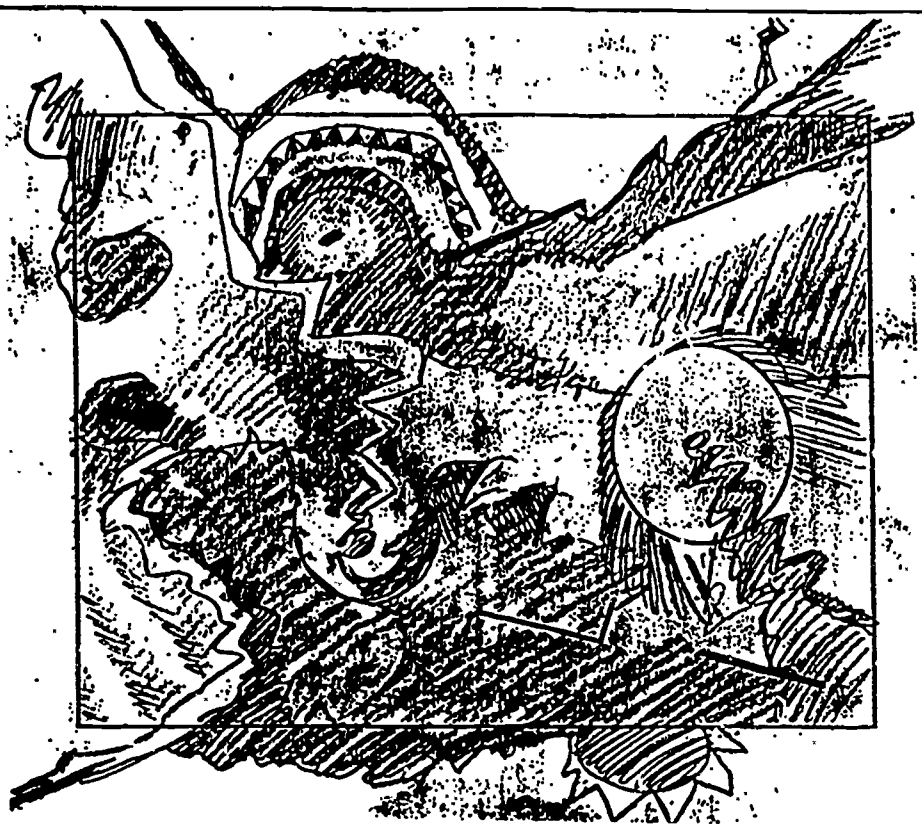
Category 1: Separate Motif



Category 2: Confined to Signal Line Area

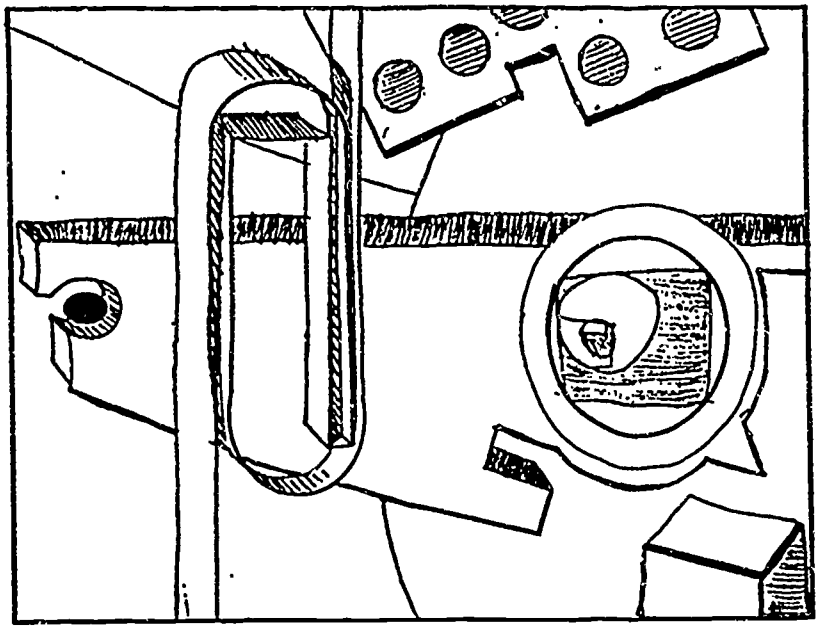


Category 2: Confined to Signal Line Area

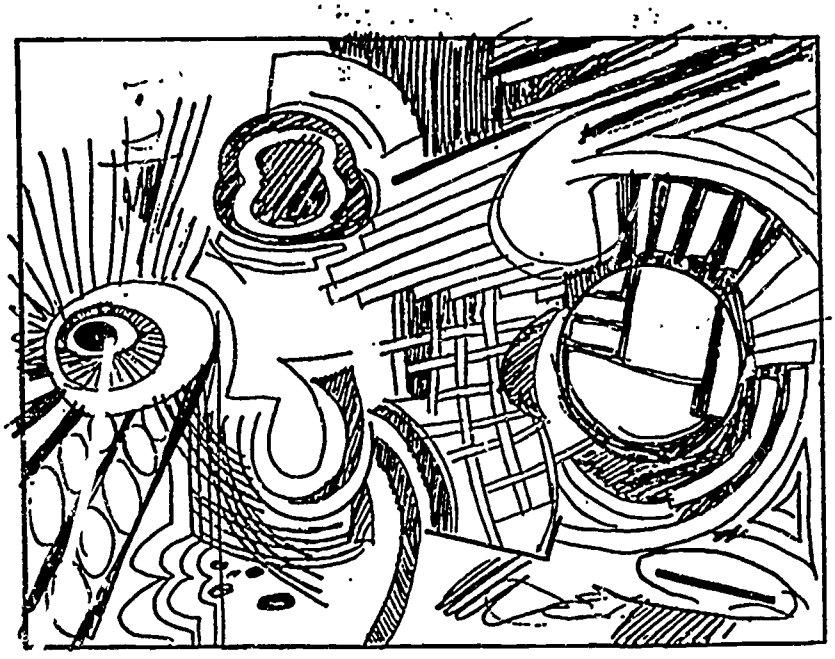


Category 3: Visually Directed Movement

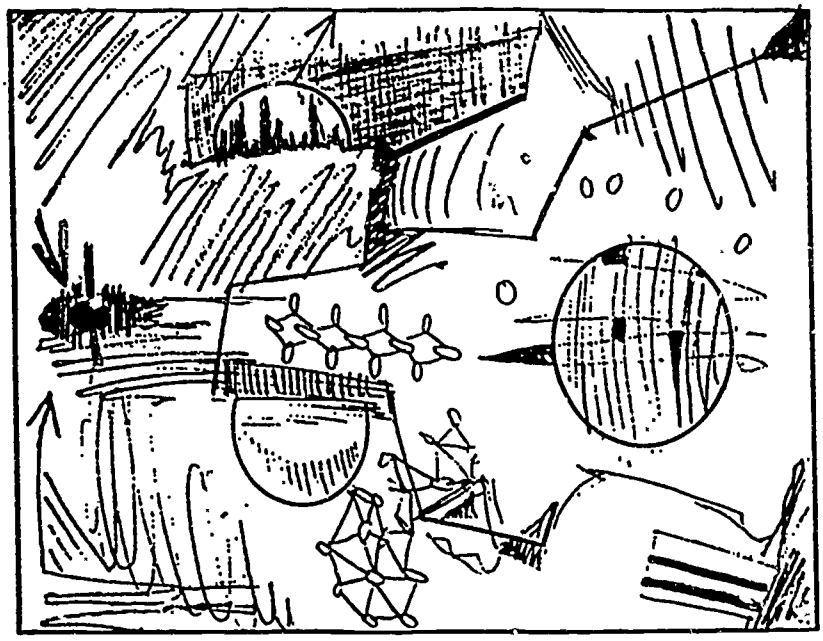
Category 3: Visually Directed Movement



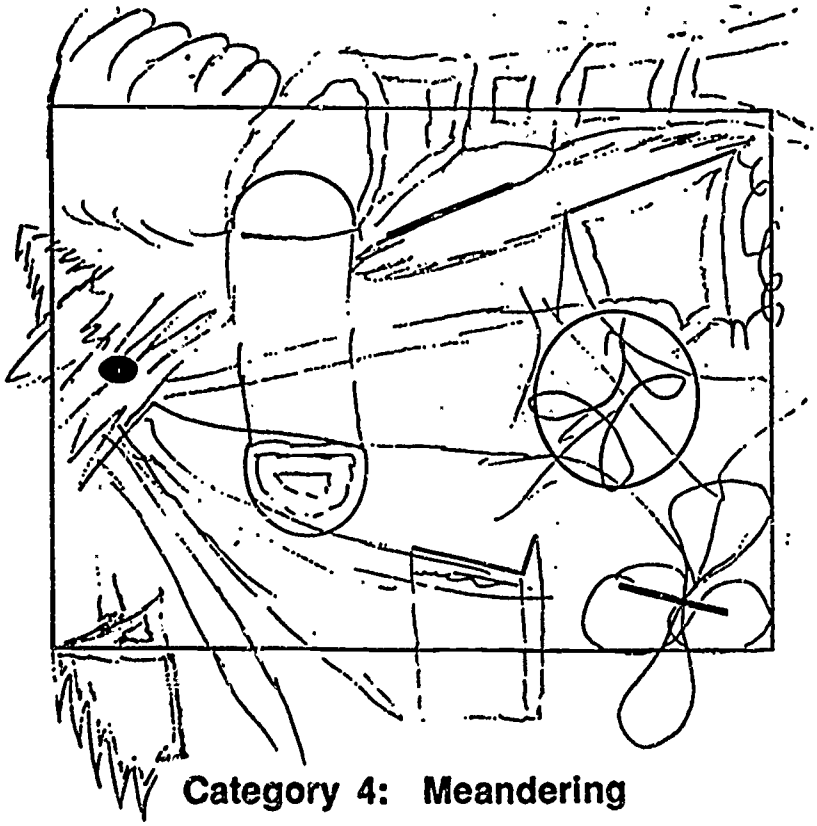
Category 3: Visually Directed Movement



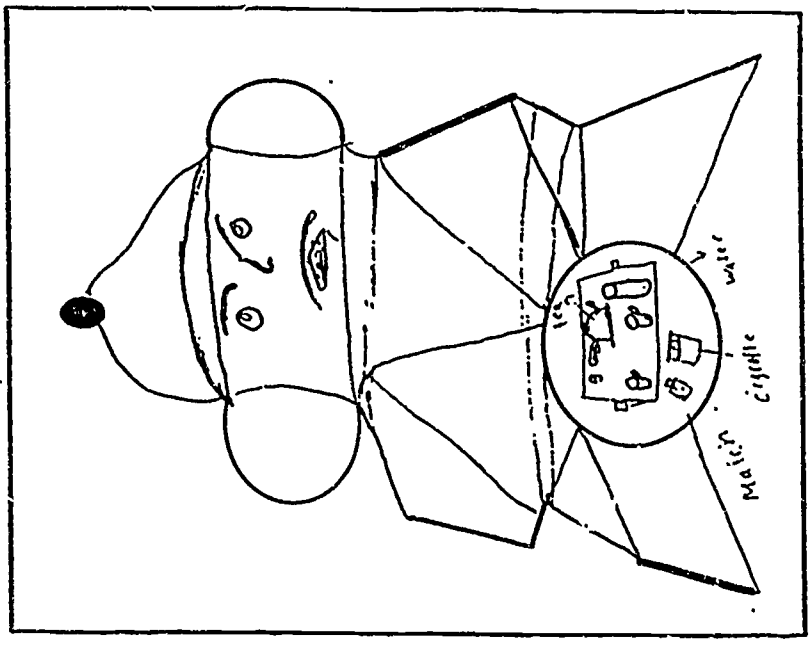
Category 3: Visually Directed Movement



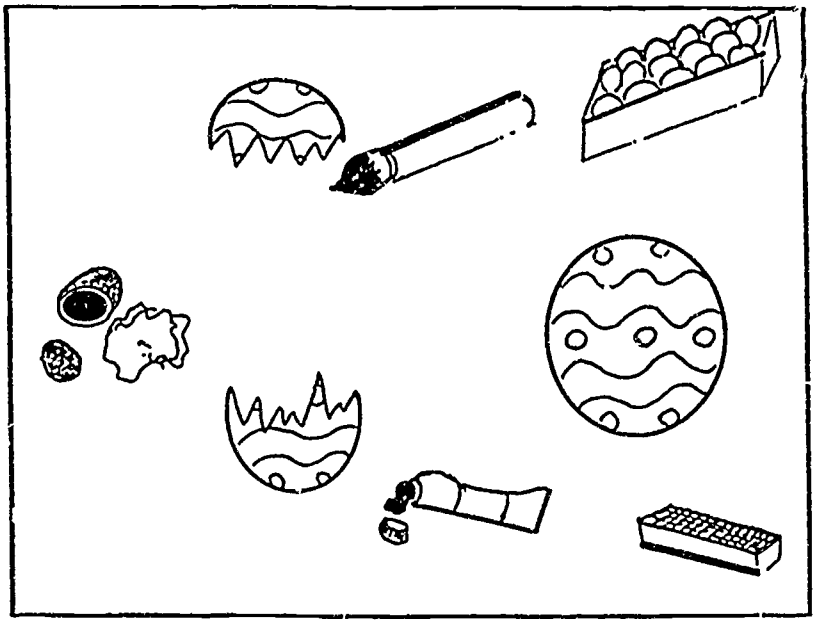
Category 4: Meandering



Category 4: Meandering



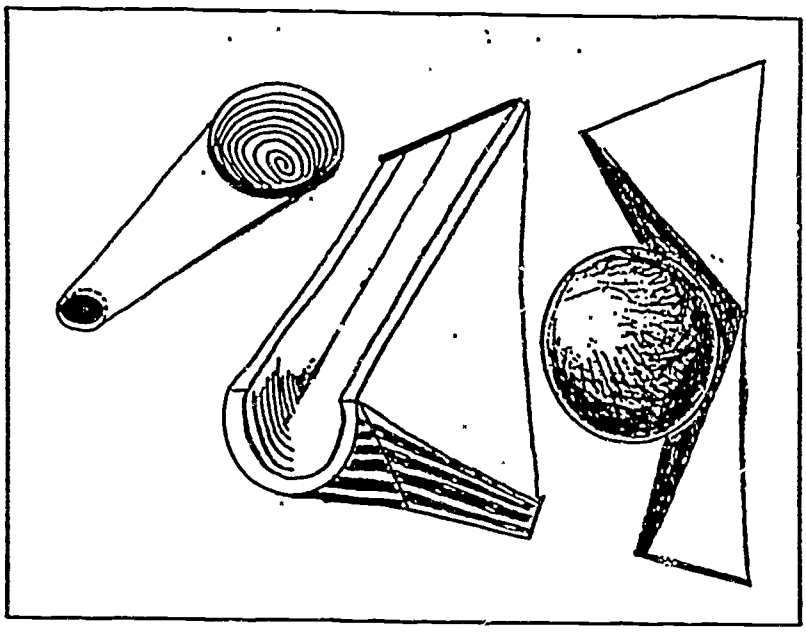
Category 5: Symbolism



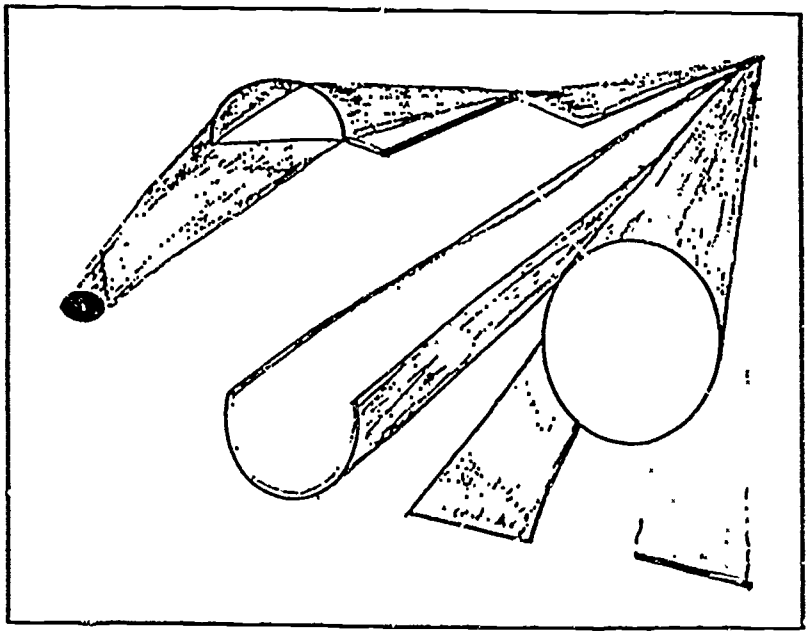
Category 5: Symbolism

Category 6: Loosely Shaded Treatment

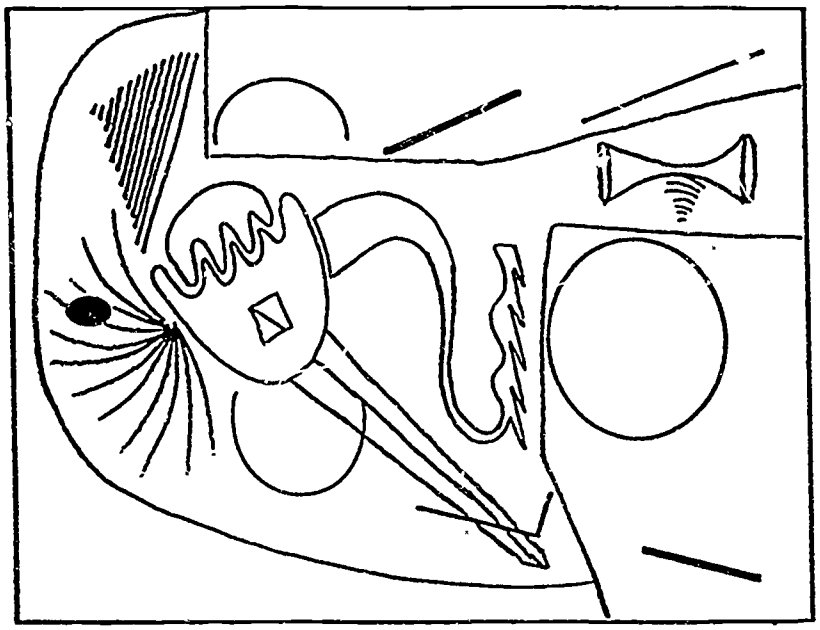
Category 6: Loosely Shaded Treatment



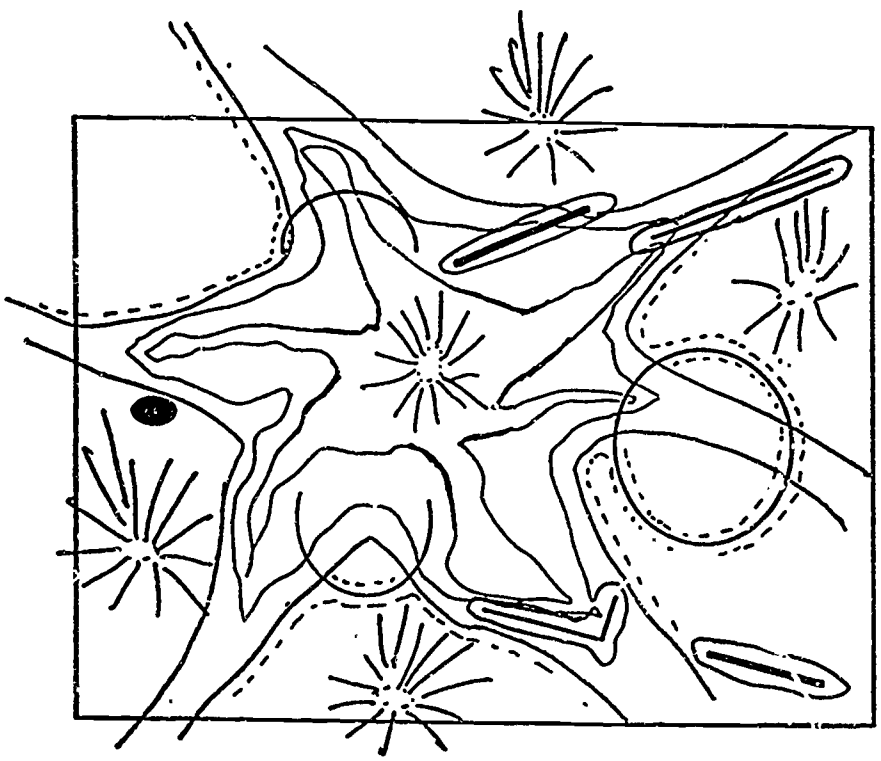
Category 7: Linear Perspective



Category 7: Linear Perspective



Category 8: Denial of Signal Lines



Category 8: Denial of Signal Lines